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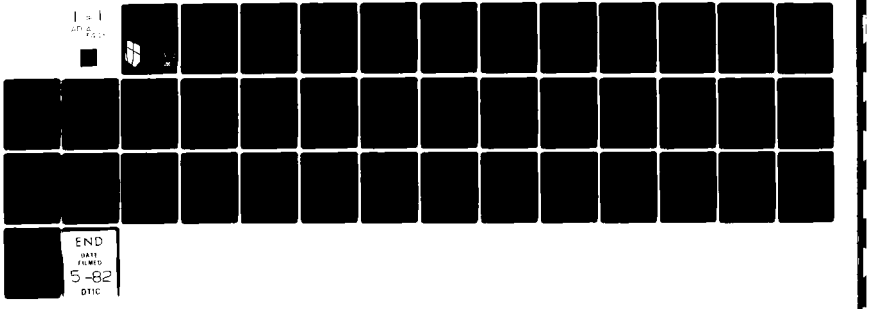

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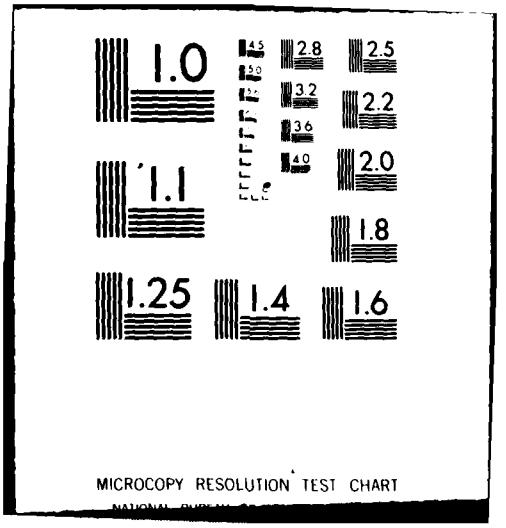
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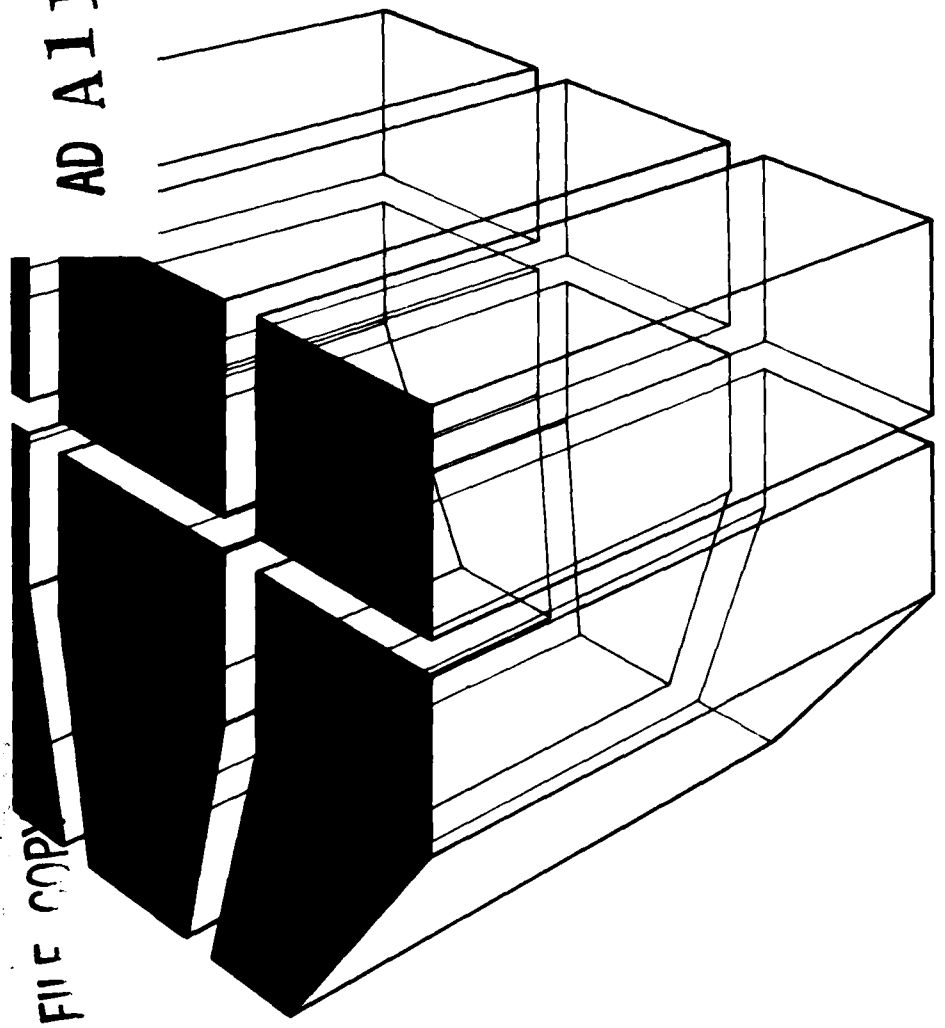
TECHNICAL REPORT P-123
April 1982

Quantification of MCA/Facilities Readiness

A CONCEPT FOR QUANTIFYING THE READINESS CONTRIBUTION OF PROPOSED ARMY FACILITIES



by
John M. Deponai III

CERL

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER CERL-TR-P-123	2. GOVT ACCESSION NO. AD-A113445	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* A CONCEPT FOR QUANTIFYING THE READINESS CONTRIBUTION OF PROPOSED ARMY FACILITIES		5. TYPE OF REPORT & PERIOD COVERED FINAL 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) John M. Deponai III		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. ARMY CONSTRUCTION ENGINEERING RESEARCH LABORATORY P.O. Box 4005, Champaign, IL 61820		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 4A762731AT41-B-031
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE April 1982 13. NUMBER OF PAGES 37
14. MONITORING AGENCY NAME & ADDRESS *(if different from Controlling Office)*		15. SECURITY CLASS. *(of this report)* Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

Copies are obtainable from the National Technical Information Service
Springfield, VA 22161

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

mathematical models
construction
readiness

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report describes three versions of a model concept developed by the U.S. Army Construction Engineering Research Laboratory for quantifying the force readiness contribution of a proposed facility relative to the contribution of other facilities. All three versions of the concept have six favorable characteristics. They are (1) logically simple, (2) complete, (3) consistent, (4) efficient in conflict resolution, (5) flexible to changes in managerial decisions, and (6) integrated and dynamic.

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FOREWORD

This investigation was conducted for the Directorate of Military Programs, Office of the Chief of Engineers (OCE), under Project 4A762731AT41, "Design, Construction, and Operation and Maintenance Technology for Military Facilities"; Task B, "Construction, Management, and Technology"; Work Unit 031, "Quantification of MCA/Facilities Readiness." The applicable STO is 81-8:7. The OCE Technical Monitors were COL Carpenter, COL Coats, LTC Godfrey, and LTC Edwards, all of DAEN-ZCP-R.

The cooperation and advice of COL Edward G. Rapp and LTC Lynn Shaw, both formerly of DACS-DPA, are gratefully acknowledged.

The work was performed by the Facility Systems Division (FS) of the U.S. Army Construction Engineering Research Laboratory (CERL). Mr. E. A. Lotz is Chief of CERL-FS.

COL Louis J. Circeo is Commander and Director of CERL, and Dr. L. R. Shaffer is Technical Director.

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1 INTRODUCTION

Background

In July 1978, the U.S. Army Construction Engineering Research Laboratory (CERL) was tasked by the Office of the Chief of Engineers (OCE) to develop a model to relate military construction to force readiness. After extensive coordination with Department of the Army (DA) general and special staffs, it was determined that the model would be used primarily by the Construction Requirements Review Committee (CRRC). The CRRC is an advisory committee to the Assistant Chief of Engineers and is responsible for formulating, coordinating, and justifying the Military Construction, Army (MCA) program.

Purpose

The purpose of this report is to describe three versions of a model concept for quantifying the relative impact of proposed MCA projects on the readiness state of the Army.

Approach

Several preliminary model outlines were developed by CERL and critiqued by individuals on the Army staff. Based on those critiques, a concept model was formulated and presented to the CRRC. The concept was approved and a computer-based pilot model was developed and demonstrated. After this demonstration, the model was modified significantly to allow the CRRC more flexibility in controlling certain key parameters. The CRRC tested this modified concept by using it to evaluate the relative readiness worth of 61 projects proposed for the Fiscal Year (FY) 82 MCA program. All calculations and data analyses were done using programmable calculators. In 1980, the Army adopted a Mission Area Analysis approach to program evaluation, eliminating the requirement to determine the readiness worth of individual funding entities. CERL revised the model so it could be used at the CRRC's option (with programmable calculator support only) to determine the relative readiness merits of a few projects in the MCA program.

Mode of Technology Transfer

This report constitutes the technology transfer medium for the concept for quantifying the readiness contribution of proposed Army facilities.

2 FORCE READINESS QUANTIFICATION CONCEPT

General

The Army must respond effectively to constantly changing threats to the nation's security. It is generally accepted that a mission orientation provides the best planning framework. There are many ways to organize the defense mission universe. Because the threats, and therefore Army missions, are constantly changing, it is unlikely that any *detailed* mission orientation can be devised that would be completely stable from one year to the next. The planning environment is just too dynamic. The programming environment is even more dynamic because it is influenced both by the planning orientation and by the current administration's program guidance. Such program guidance usually changes with each new administration.

The Army's program is developed and packaged to conform to the planning and programming guidance for that year. At certain points in the process, committees estimate the relative worth of packages competing for funds. Because packaging is the result of a dynamic formulation process, the evaluator's frame of reference changes each year. Moreover, as issue and funding decisions are made at each level, the actual worth of a particular Program Development Incremental Package (PDIP) changes as components are added or subtracted. The PDIP worth as originally determined by an Army committee rapidly can become invalid.

If each funding entity could be assigned a force readiness worth relative to all other funding entities soon after it is first submitted to DA as a funding need, the force readiness worth of any package of entities could be set equal to the sum of the force readiness worths of the individual entities in that package at any particular time. Thus, changes in the force readiness contribution of a program caused by sudden changes in mission emphasis could be determined almost immediately. Then, sensitivity analyses could be run on alternate programs. Program evaluation could be separated from planning and program packaging activities. Program packaging and formulation could be done in light of initial evaluation data, instead of after the program is packaged and almost completely formulated. Values for subjective evaluation parameters other than readiness, such as safety, environment, quality of life, and morale, also could be developed in a similar manner. The values developed for qualitative issues and for quantitative issues, such as cost and energy conservation, could be used as limiting parameters in a linear program to optimize force readiness (subject to con-

straints on the total value of each parameter). By varying the limits on these parameters, several strawman programs could be formulated, analyzed, and debated. The best strawman program then could be adjusted manually to accommodate logical inconsistencies, political considerations, appropriation limits, personal preferences, etc.

In the CERL quantification concept, top managers directly influence the readiness worth of each funding entity by controlling the weights assigned to standard mission objectives. Middle managers at each intermediate level directly influence the readiness worths by deciding the size of "merge factors" at each level. Top managers also decide the size of merge factors at the top level. Operations-level staff officers influence the readiness scores by deciding (1) the relative functional and operational worth of each funding entity in a given homogeneous group, and (2) the percentage of each funding entity contributing to each standard mission objective. Thus, the final evaluation is the result of an integrated, dynamic, corporate decision.

Although the readiness quantification concept was developed to determine the relative readiness worth of funding entities (facility projects) in the MCA program, the concept could be extended to relate the readiness worth of all funding entities to a common base (Army- or DOD-wide). Figure 1 shows, in general terms, how the concept could be extended to even the DOD level.

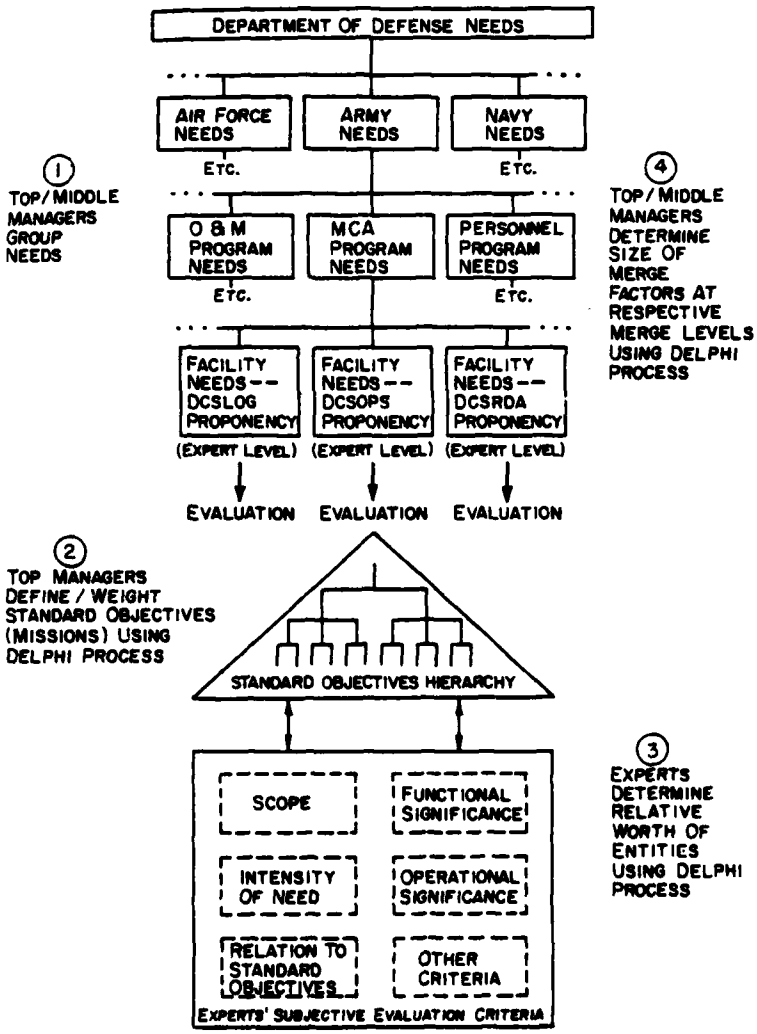


Figure 1. Extension of concept to DOD level.

1. Top- and middle-level managers decide how to organize needs. This is essentially a one-time decision and does not necessarily depend on the planning orientation adopted for a particular year. Needs should be grouped successively into more operationally or functionally homogeneous groups until a manageable number of projects are in each of the lowest level groups. Existing, widely accepted, and well-defined functional and/or organizational schemes should be exploited. Managers at each level should have the authority to decide how to organize their needs. (Note that the MCA program also could have been broken down by using the Army Regulation [AR] 415-28 facility classification scheme.[1])

2. Top managers establish and weight the standard objectives hierarchy. For the force readiness objective, this would be a mission-oriented hierarchy. Such a hierarchy should have certain properties. It should be stable over a long period of time, address the entire mission universe, display the mission universe in a mutually exclusive way, and be simple to understand and to work with. Ideally, it should have about four to 10 subobjectives (mission nodes), because the average person's comprehension span is generally believed to include about seven objects. Less than four subobjectives probably would not discriminate among the quantification results well enough; using more than 10 would greatly increase the computational burden. Also, if many more than 10 are used, the results probably would be less accurate because the success of the quantification method depends on the ability of operations-level staff officers to assess the relationship of each funding entity to each mission subobjective in light of the total mission.

Figure 2 presents an example mission hierarchy used by the CRRC in July 1980 to rate 61 projects proposed for the FY82 MCA program. The hierarchy in Figure 2 is based on the three major issues: modernization, Europe first, and win the first battle. Note that complements of these issues are also addressed by the hierarchy. The July 1980 test of the concept showed that for MCA projects, the present vs future issue (modernization) did not provide significant additional discrimination among projects. Yet including that distinction doubled the number of subobjectives. The mission hierarchy shown in Figure 3 was subsequently recommended. The goal is to use the least amount of effort to get the maximum readiness discrimination among projects. Relating entities to missions is a means to an end (i.e., discrimination), not an end in itself.

[1] *Facility Classes and Construction Categories (Category Codes)* Army Regulation (AR) 415-28 (Department of the Army, 1 November 1981).

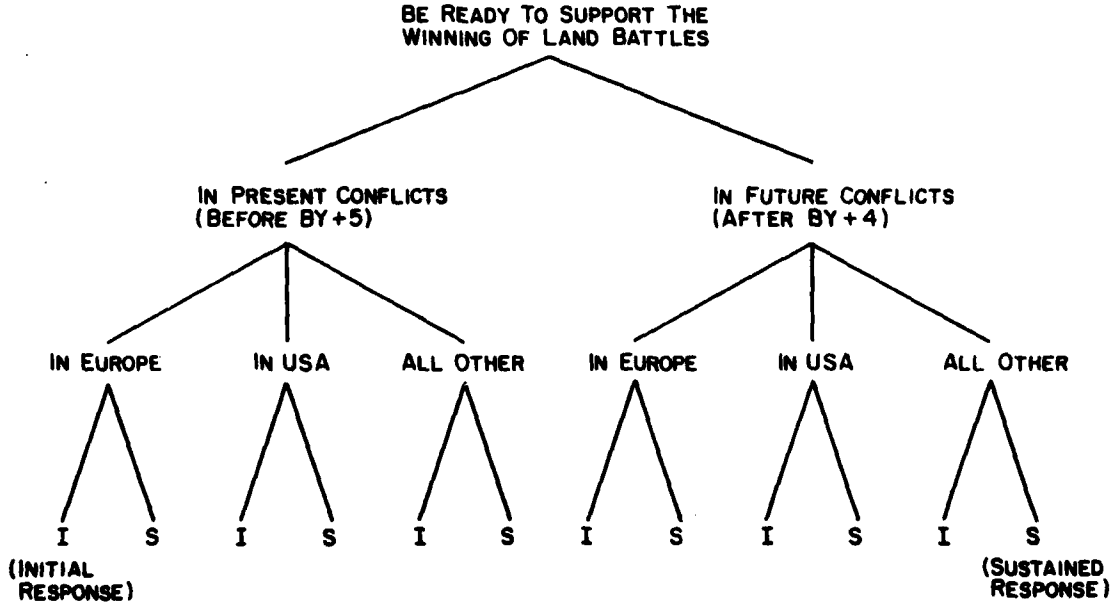


Figure 2. Mission hierarchy used at the CRRC in July 1980 to rate 61 MCA projects.

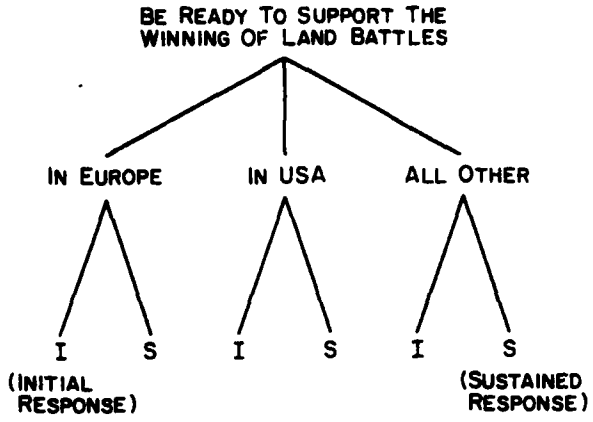


Figure 3. Amended hierarchy.

A Delphi process for weighting the mission hierarchy is recommended, and ideally, mission weighting should be done by top-level management. The Delphi process is based on the hypothesis that *on the average* the *median response* of a group is closer to "truth" than the response of any one person in that group. Three features—anonymous response, iteration/controlled feedback, and statistical group response—are part of the Delphi method and essential to the readiness quantification concept.[2]

3. A panel of seven to 10 staff officers at the operational-staff level use the Delphi method to determine the relative worth of the funding entities in their operational area. Each expert on the rating panel applies his* own subjective criteria to determine the relative readiness contribution of each funding entity with respect to all others in his operational area. (Chapter 3 describes this process in more detail.)

4. At each higher merge level, a committee of managers decides the relative worths of all projects subordinate to that particular level. For example, at the major program level, projects in the MCA program are merged with projects in the Operation and Maintenance (O&M) program and with projects in the other major programs by selecting a *sample* of projects from each program and comparing their relative worths. (A separate sample would be required for each parameter other than readiness.) After the relative standings of the merge samples are decided, *all* the projects in each population from which the samples were taken would be assigned the same merge factor. One merge factor would be assigned for each parameter being considered. This process is repeated at each classification level until the highest level is reached. The result is that all objects in need of funding are related within the same frame of reference by their initial values (as determined at the operations-staff level) and by a series of merge factors. The size of the merge factor at each level would be hidden from the evaluators at lower levels to discourage lower-level evaluators from gamesmanship. The process is dynamic, since the merge process would be reviewed both annually and as significant events altered the international situation. The process would address *all* identified funding needs; those in the program year, and those in the "out years." For each funding entity, the concept creates, at the lowest level, one value that represents that funding entity's parametric worth relative to all other funding entities. (Readiness is only one of the many parameters that could be considered.)

The process is sequential the first time through. After that, the force readiness worths would be updated continuously as new entities are added, as changes are made to the merge factors at every level, and as changes are made to the mission weights by top-level management.

Definitions/Perspectives

For purposes of this report, force readiness is defined to be the degree to which a force is capable of accomplishing the requirements of the specific mission(s) or contingency plan(s) for which it is responsible. A force is defined as an assemblage of resources formed to accomplish a mission(s). Thus, force capability can be viewed as being directly related to the level of fulfillment of those resources needed to accomplish the mission.

Manpower Required

After the staff becomes familiar with the model concept, about 5 manyears of evaluation effort would be required to execute one cycle of the concept Army-wide. This is effort required over and above the time normally spent becoming familiar with the projects. Also, it assumes the existence of a sophisticated computer program to support the concept. The 5-manyear estimate was derived as follows: In the July 1980 test of the concept, the CRRC rated 61 projects, worth $227 million, in 16 hours. Assuming (1) the method is applied to evaluate the relative worth of the components of only the last 25 percent of a $40 billion Army

[2] Norman C. Dalhey, *The Delphi Method: An Experimental Study of Group Opinion*, RM-5888-PR (RAND Corporation, June 1969).

*The male pronoun is used throughout this report to refer to both genders.

program, (2) 10 men are on each rating panel, and (3) there are 1840 hours in a manyear, then

$$(40{,}000^{M} \times 0.25) / 227^{M}) \times 16 \frac{\text{manhours}}{\text{man}} \quad \text{[Eq 1]}$$

$$\times 10\,men / 1840 \frac{\text{manhours}}{\text{MY}} = 3.8, \text{ or about 4 manyears.}$$

The time needed to assign merge factors and weight the mission hierarchy is far less than the time needed to determine the basic ratings by the panel of experts. Therefore, treating these efforts as an overhead value requiring 25 percent additional effort gives a total effort value of 5 manyears. This is the estimated steady-state level of effort for one cycle, and does not include the time needed to train people in using the model and its associated computer system.

Basic Concepts

Using subjective criteria and Delphi techniques, experts generate a readiness benefit/cost (B/C) ratio for each funding entity. The total benefit (B_T) for each project is the sum of readiness benefits (B_R) and nonreadiness benefits (B_{NR}):

$$B_T = B_R + B_{NR} \quad \text{[Eq 2]}$$

The total cost (C_T) of the entity theoretically can be assigned to readiness costs (C_R) and nonreadiness costs (C_{NR}):

$$C_T = C_R + C_{NR} \quad \text{[Eq 3]}$$

where C_T also equals the Program Amount ($PA).

The ultimate B/C ratio used is relative readiness benefit to total entity cost:

$$B_R/C_T = B_R/\$PA \quad \text{[Eq 4]}$$

where $PA is the estimated program dollar amount of the entity. Figure 4 shows this relationship.

As an intermediate step in the process, raters interact with the model to define a readiness benefit to readiness cost ratio (B_R/C_R) for each project. This ratio represents a funding entity's readiness contribution rate relative to that of all other funding entities. The benefits are measured in relative units of force readiness utiles, not in dollars. The B_R/C_R ratio is constrained between zero and some arbitrary maximum value. This value varies as funding entities from the different experts' lists are related to different frames of reference. In other words, the *intermediate* ratio, B_R/C_R, not the *ultimate* ratio, $B_R/\$PA$, must be used to merge funding entities. The ultimate ratio is derived by multiplying the intermediate ratio by the fraction (C_R/C_T) of the project cost attributed by operations-level raters to readiness (Figure 5). The fraction C_R/C_T, is essentially an assessment by the operations-level raters of what the bare-bones readiness cost of the funding entity really is. The ultimate ratio must be used to do tradeoff analysis: to buy the readiness benefit, one also must be willing to buy the nonreadiness benefits, if any, that are designed into the entity. It is conceivable that an entity could be redesigned to provide *only* readiness benefits, but this usually would provide an artificial solution that would not relate well to the real world. (The purpose of the concept is to provide a way to model the real world, not to change the real world to fit the model.)

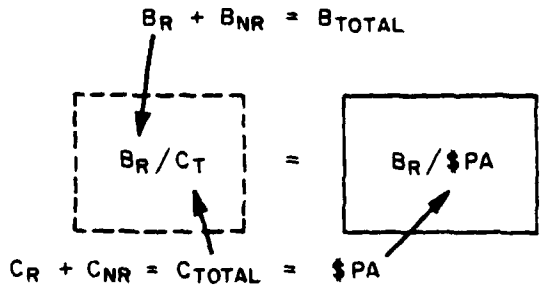


Figure 4. Benefit and cost component relationships.

Model Benefits

The model has eight principal benefits:

1. It provides funding justifications based on readiness worths that are consistent across the total program.

2. It disciplines the decision-making process.

3. It provides an audit trail of the relative influence of each readiness component.

4. It discriminates among marginal funding entities by identifying each entity's relative readiness worth.

5. It shows the relative impact that changes in mission and/or program formulation have on force readiness.

6. It can be used to generate strawman programs based primarily on readiness contribution.

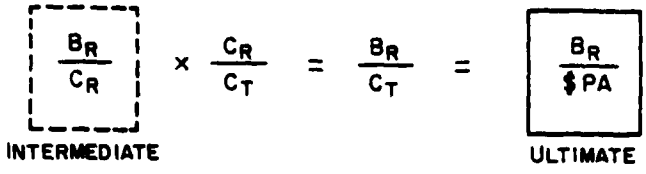


Figure 5. Deriving the ultimate B/C ratio from the intermediate B/C ratio.

7. It identifies areas of disagreement among staff.

8. It eliminates redundancy in the readiness evaluation. (Although people tend to have greater confidence in predictions based on redundant input variables, it has been shown that redundancy usually decreases accuracy.)[3]

3 FIELD TEST OF PILOT MODEL ON MCA PROJECTS

General Procedures

In July 1980, the CRRC tested the readiness quantification concept on 61 MCA projects being considered for the FY82 program (Figure 6). During this test, the CRRC functioned at all three management levels:

1. At the operations level, each project's B_R/C_R was developed.

2. At the middle-manager level, merge factors were determined.

3. At the top-manager level, the readiness subobjective (mission) weights were determined.

At each stage of the process, each CRRC member recorded his first pass opinion as to the relative value of that factor for each project. Then, the CRRC as a whole was advised of the median, low quartile, and upper quartile values of the group response and the results were debated. Each CRRC member then submitted a second-pass value for each factor for each project before going on to the next step of the process.*

Data processing was done between CRRC sessions by CERL using programs written for a Texas Instruments (TI)-59 calculator. (The programmable calculators were used to simulate the proposed computer system support to the concept.)

Test Procedure—Step 1

Figure 7 shows how the CRRC defined force readiness. It took the CRRC about 20 minutes to develop a common perspective on what readiness contribution means in an operational sense. This working definition lists primary readiness contribution areas, not secondary, tertiary, etc. effect areas. Note the definition includes not only what readiness *is*, but also what it *is not*. (This definition would be revised and expanded as time goes on to reflect real-world situations.)

Test Procedure—Step 2

The CRRC discussed the hierarchy of the mutually exclusive, all-inclusive readiness objectives (missions) established before the test. The results of this 40-minute exercise are shown in Figure 8. Figure 9 displays the second-pass median results of weighting the mission hierarchy. Weighting the hierarchy can be done either by distributing an arbitrary 100 points directly across all 12 subobjectives, so the weights sum to 100 at each level of the hierarchy (as in the top box of Figure 9); or by using a ratio scheme to relate the subobjectives (as in the lower box of Figure 9). If the ratio scheme is used, the values in the top box of Figure 9 would be calculated by the computer system supporting the model. A ratio scheme usually produces more extreme

[3] Milan Zeleny, "Managers Without Management Science?" *Interface*, Vol. 5, No. 4 (August 1975).

*Although this method produced good results, it may have been more efficient to delay the feedback until *all* steps had been completed at least once.

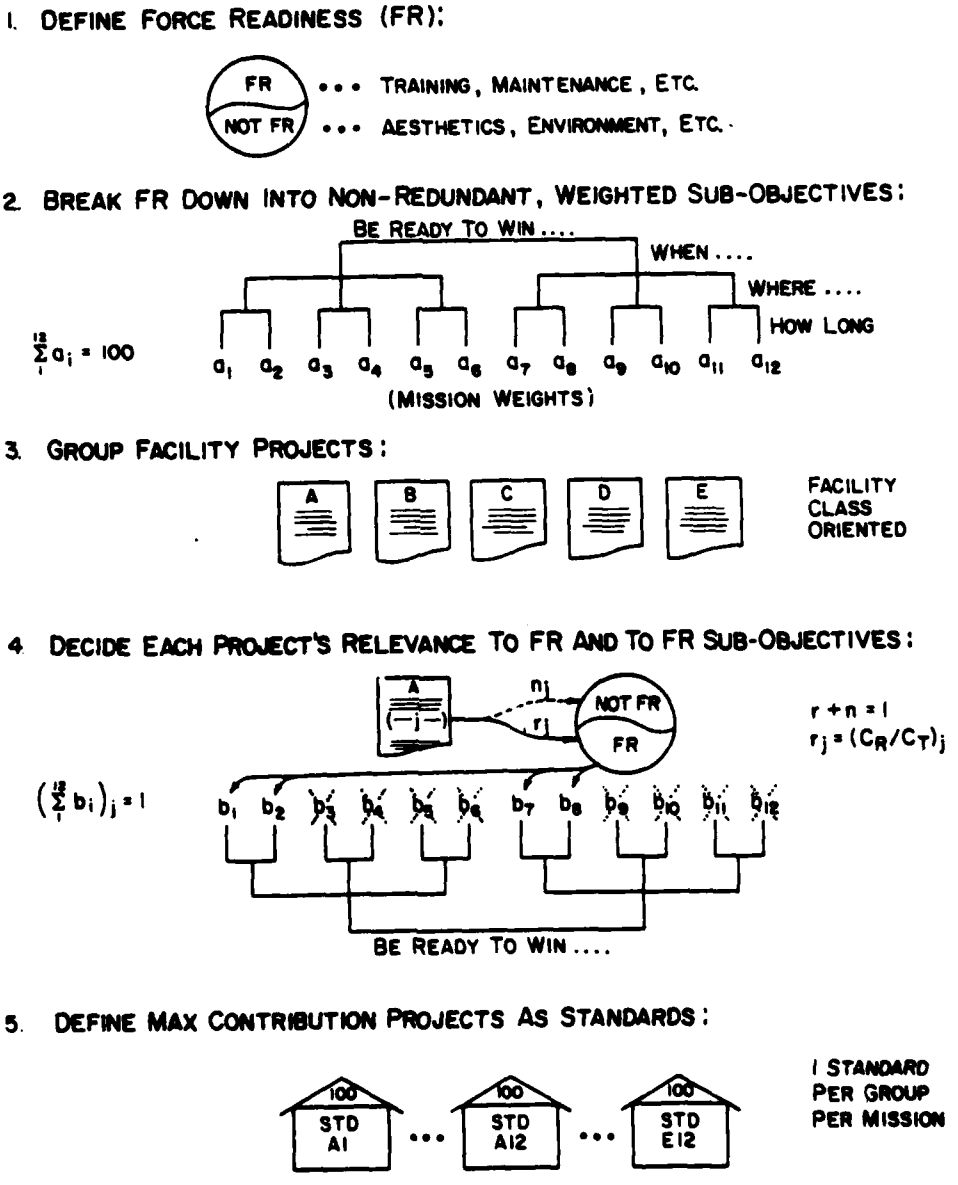
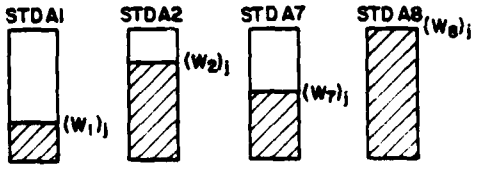


Figure 6. Procedures used in the field test of the pilot model (Version 1).

6. COMPARE PROJECT WORTHS TO APPROPRIATE STANDARDS :

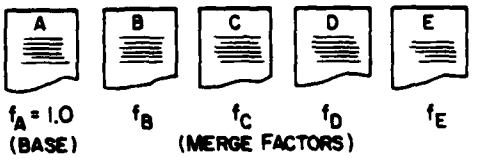


TEST AVERAGE :
3½ COMPARISONS
PER PROJECT

7. COMPUTE EACH PROJECT'S INTERMEDIATE B_R/C_R:

$$\left(\sum_{i=1}^{12} a_i b_i w_i\right)_j = (B_R/C_R)_j$$

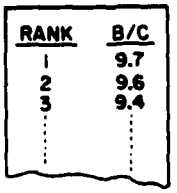
8. MERGE B_R/C_R RATIOS IN EACH GROUP TO COMMON BASE :



9. COMPUTE FINAL B_R/C_T FOR EACH PROJECT :

$$(B_R/C_R)_j \times f_j \times r_j = (B_R/C_T)_j = (B_R/\$PA)_j$$

10. REVIEW AND DISCUSS RESULTS :



RANK	B/C
1	9.7
2	9.6
3	9.4

Figure 6. (Cont'd).

Force Readiness Includes:

- –Training
- –Maintenance
- –Command, Control, Communication (C^3)
- –Security
- –Manning the Force
- –Making Military Operations More Efficient

Force Readiness Does Not Include:

- –Aesthetics
- –Occupational Safety and Health Act (OSHA) Compliance
- –Pollution Abatement
- –Energy Conservation
- –Environmental Enhancement
- –Convenience of Operations

Figure 7. Working definition of force readiness.

distributions than the alternative points scheme and is easier to use. Each entry is determined independently, and the user does not have to ensure that his entries sum to 100. The resulting feedback is direct and easy to understand.

In the alternate points scheme, the median, low quartile, and high quartile feedback are difficult to present and understand. Also, because each subobjective feedback value must be considered independently, the sum of the feedback values for any one project is usually not 100.

The field test second-pass median ratings are shown in the lower box of Figure 9, and they result in the distribution of values shown in the upper box. It took the CRRC 1-1/4 hours to do both the first- and second-pass ratings. As mentioned, these ratings normally would be done by top management and conceivably would change frequently during the year.

Test Procedure–Step 3

During the field test, the CRRC arbitrarily decided to group the 61 facility projects as shown in Figure 10. This process took about 15 minutes. (Although these groupings worked well enough for the field test, a proponency orientation was subsequently determined to be more meaningful to the CRRC.)

Test Procedure–Step 4

Figure 11 shows the field test second-pass results. Each CRRC rater assigned a value to each project for project relevance to force readiness (r_j), and up to 12 values $(b_i)_j$, to show the distribution of that project's benefits among readiness subobjectives. It took 5-1/2 hours to complete these two passes. *The b values have been normalized to sum to 1 across all mission subobjectives.* Note that the *feedback* values for each subobjective of each project are independent of each other. In other words, one should not expect the low quartile, median quartile, or high quartile *feedback* values for a project to sum to 1. This is similar to the feedback display problem discussed with respect to evaluating the mission weights. An alternate ratio-based rating scheme cannot be used in this step, however, because any one of the panel members could assign 0 to any subobjective; this presents the possibility of division by 0, thus invalidating the ratio scheme. A ratio scheme works for mission weighting only because, by definition, *each* of the missions must have a weight. That is not so in this step. A facility project to be built in one theater of operation may or may not be related to success in another theater of operation.

The problem with Step 4 is the format used to give raters the low quartile, median, and high quartile rating results. One sheet of paper per facility project is needed to communicate the results effectively. Up to 39 feedback values—three for the readiness relevance scores and three for each of the 12 subobjective relevance scores—have to be recorded. This creates quite a bit of paperwork, assuming that more than one or two sets of ratings will be submitted by at least some of the raters. But a sophisticated, interactive computer support system would permit each rater to input changes and have the results computed and displayed immediately, thus eliminating both paperwork and processing burdens.

In Figure 11, only a few projects were scored as contributing to the success of "Present Conflict" subobjectives. This suggests that, for the MCA programs, the objectives hierarchy could be halved by eliminating the distinction between "Present" and "Future" missions.

Test Procedure–Step 5

Figure 12 shows the maximum contribution projects defined for 40 subobjective areas. Actually, 60 such standards ultimately would have had to be developed to describe the maximum contribution facility of each of the five facility groups with respect to each of the 12 mission subobjectives. But for the field test, only those standards needed to compare the facility projects actually being rated were defined. It took the CRRC

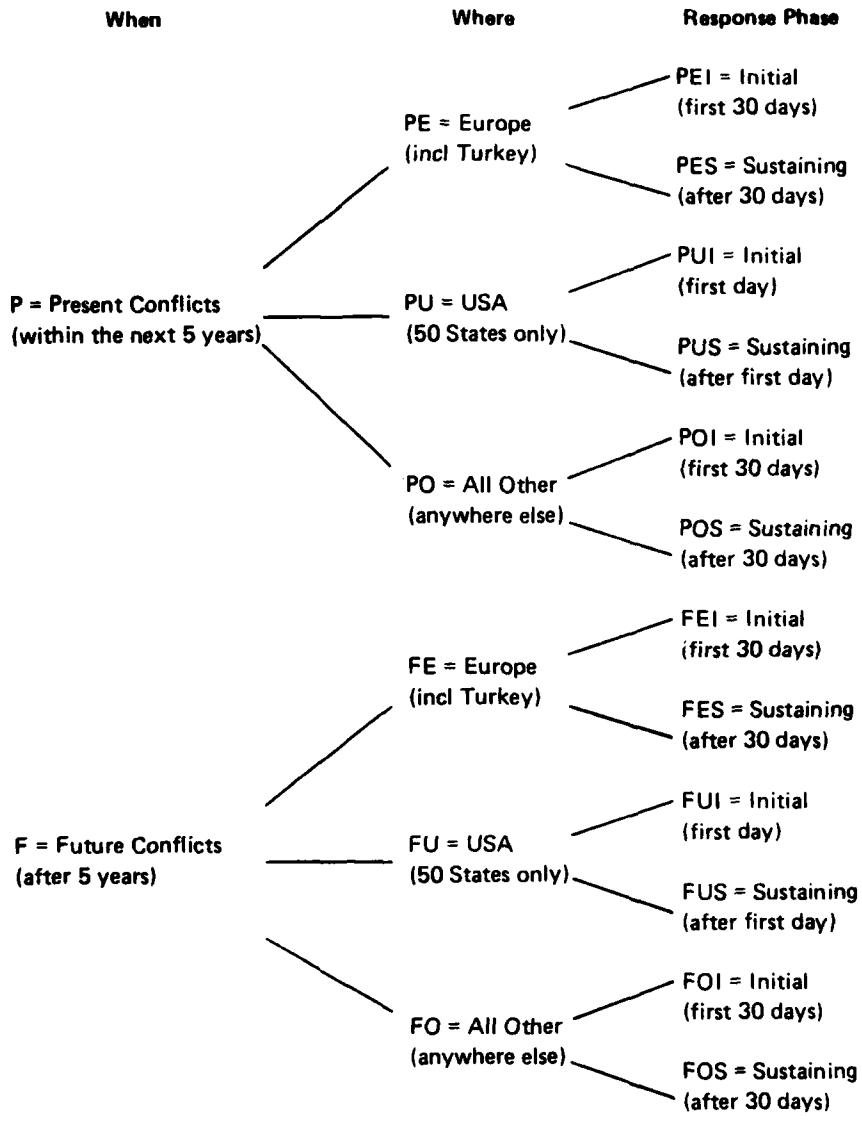


Figure 8. Working definitions of readiness subobjectives.

panel 2 hours to come to a general agreement on what a "maximum contribution" project was for each of the 40 standards. Note that these standards were fairly vague. It is not efficient nor desirable to spend a lot of time initializing this aspect of the process, because there certainly will be more than one example of a maximum contribution project and, as time goes on, the raters will identify many real-life projects as such. These real-life examples then would replace the hypothetical examples. Note the standards relate to all existing or planned facilities within the particular frame of reference for which the standard is being developed. The standard is *not* just an example of the most valuable *unfulfilled* need in that reference frame. It is the standard for *all possible entities* in a particular group's subobjective frame of reference.

Test Procedure—Step 6

Figure 13 shows the second-pass median scores for the raters' estimates of the relative worth—$(w_i)_j$—of each facility project. The CRRC panel took 2-1/2 hours to make their estimates. Project evaluations were made only against those subobjectives to which a project contributed. Those subobjectives for which the

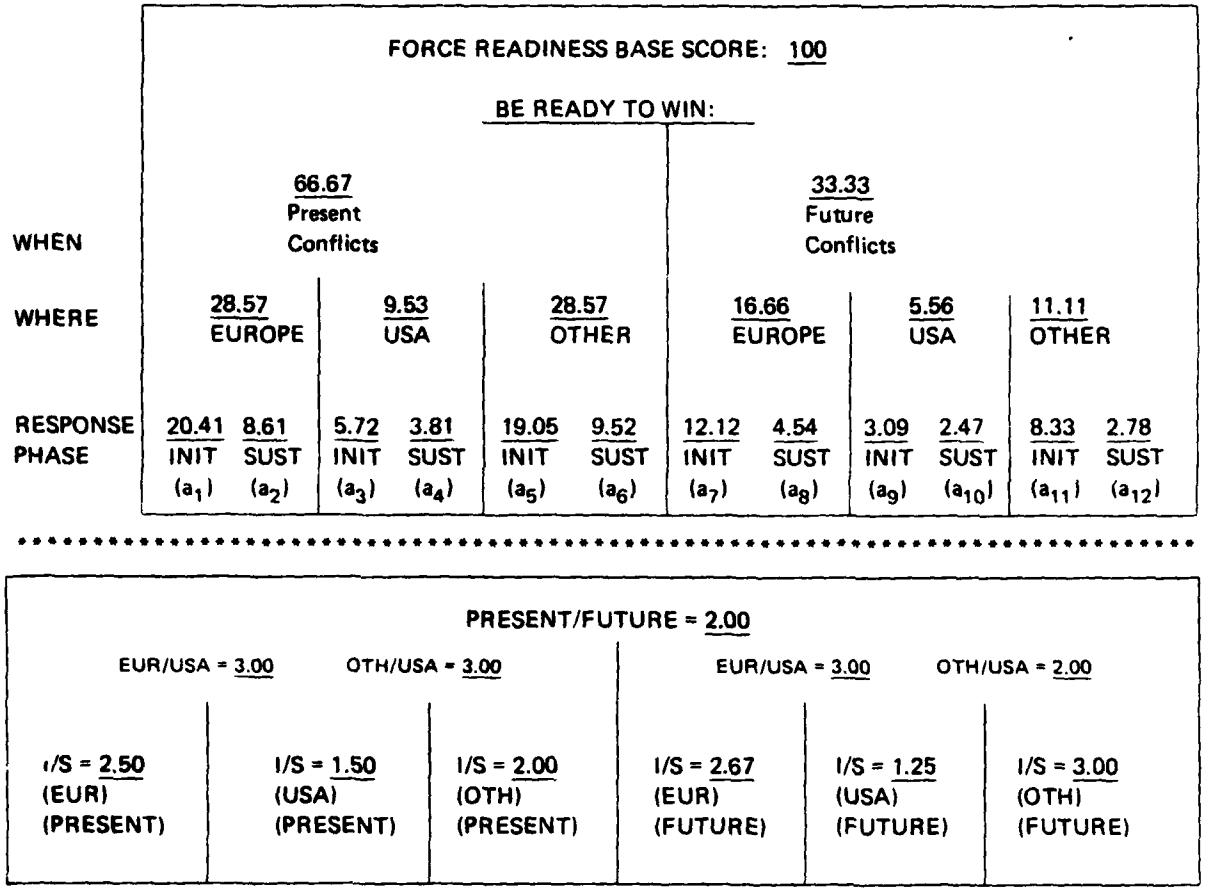


Figure 9. Relative weights of readiness subobjectives determined during field test.

project has an adjusted median subobjective relevance score greater than 0 (determined in Step 4) are the official subobjectives to which the facility project contributes. Note that it is not necessary to adjust these median scores to a base figure. Each feedback value is independent of all other feedback scores. The volume of feedback in this step is as severe as in Step 4. However, an interactive, real-time, computer support system would significantly improve the speed and efficiency of Step 6.

Test Procedure—Step 7

Figure 14 gives six examples of how intermediate B_R/C_R ratios were calculated for each project. All Step 7 calculations were done at CERL. These calculations would have to be done on a computer system for all but minor applications of the concept.

Test Procedure—Step 8

Figure 15 shows the merge factors developed by the CRRC panel. These factors are the median values of the second-pass rating scores. It took the CRRC 2 hours to complete Step 8; most of that time was spent discussing the intermediate results.

Test Procedure—Step 9

Figure 16 gives examples of how to transform the intermediate project ratio, B_R/C_R, into the final ratio, $B_R/\$PA$. These calculations were done manually at CERL. This step involved no CRRC time.

Test Procedure—Step 10

The CRRC spent 1-1/2 hours discussing the final results of the field test (Figure 17). Note that a project with a B/C ratio less than 1 is still feasible, because the benefits are measured in an arbitrary unit of measurement—readiness utiles. The CRRC panel took 16 hours over a 1-month period to complete the field test. Time requirements, by test activity, are shown in Figure 18. All calculations and typing were done at CERL. An average of 10 CERL manhours was required to support every hour of CRRC time during the test. Most of this

Group A

Operational and Training Facilities (AR 415-28 "100" series projects)
Research, Development, and Test Facilities ("300" series)

Group B

Maintenance and Production Facilities ("200" series)

Group C

Supply Facilities ("400" series)
Administrative Facilities ("600" series)

Group D

Hospital and Medical Facilities ("500" series)
Housing and Community Facilities ("700" series)

Group E

Utilities and Ground Improvements ("800" series)
Real Estate ("900" series)

Figure 10. Project groupings used during field test.

time was spent computing and displaying feedback information in support of Steps 4 and 6, in making the summary calculations in Steps 7 and 9, and in organizing and displaying the information in Steps 8 and 10.

Favorable Characteristics of the Pilot Model

The model is *simple*, even with 12 mission subobjectives to be considered.

The model is *complete*; all mission possibilities are addressed. During the field test of the pilot model, three major readiness concerns (force modernization, Europe first, and win the first battle) were expanded to provide a complete mission universe.

The model is *consistent*. It fosters constructive dissension by providing a uniform structure within which to debate a project's merits. The model also records the quantitative median opinion of the rating panel as to the relative worth of a given entity. Thus, early in the Army's Planning, Programming, and Budgeting System (PPBS) process, the entity's proponent knows exactly where his entity stands and why. If a proponent (or adversary) feels an entity is misrated, he can present new facts and request another round of ratings. This uniform rating scheme compares the merits of all funding entities without stifling the individual rater's subjectivity.

The model is *flexible*. Ratings can be changed as more information becomes available about the entity being evaluated or as the mission situation is affected by changes in the world situation, advances in technology, etc.

The model is *efficient*. Areas of disagreement can be pinpointed rapidly. Because the model provides a common logic train for its evaluations, arguments for and against an entity's funding merits can be developed and debated most efficiently. Readiness issues can be segregated from political issues; emotional arguments are exposed in the light of arguments based on structured logic. The focus is not on the influence of the person "pushing a project," but rather on the argument itself.

4 FORCE READINESS QUANTIFICATION OF PROJECTS IN THE MCA PROGRAM

Revised Model Description

When the results of the field test described in Chapter 3 were analyzed, it was determined from the data in Figure 11 that only 2.4 percent of total project benefits were scored as contributing to the "Present" mission subobjectives. This implies that including the "Present" vs "Future" mission distinction is not significant when MCA facility projects are evaluated. Therefore, the model was altered to eliminate this distinction and also to group MCA projects by DA staff proponency. Figure 19 is schematic of the revised model procedures. The *general* procedures are exactly the same as the procedures used during the field test, but the number of calculations is greatly reduced.

To determine what effect these changes might have on the final outcomes, the median ratings from the field test data were used to apply the revised procedure to the same 61 projects rated in the actual field test. These data were modified only as required to make them compatible with the revised procedures. For example, the same mission weight ratios used in the field test were used to score the "Future Conflicts" part of the mission tree. Then, 100 readiness utiles were distributed across six mission subobjectives, instead of 12. The revised mission tree definition, mission significance ratios, and resulting mission weights are shown in Figure 20. The projects were regrouped according to the proponency scheme shown in Figure 21. The same r values

					DISTRIBUTION OF PROJECT BENEFITS AMONG SUBOBJECTIVES FOR ARMY MISSION: BE READY TO WIN LAND BATTLES IN:											
					Present Conflicts (Within 5 Years)						Future Conflicts (After 5 Years)					
					T/O EUR		T/O USA		T/O OTH		T/O EUR		T/O USA		T/O OTH	
Location	Project Number	Description	Category	Rel. to FR	INIT	SUST	INIT	SUST	INIT	SUST	INIT	SUST	INIT	SUST	INIT	SUST
Korea	654	Airfld Fac Upgrade-Cp Hump	111	0.9					0.100						0.700	0.200
Okinawa	712	Pol Line Modifications–Var	125	0.8					0.107						0.413	0.480
Ft Campbell	252	CIDC Field Operations Bldg	141	0.3									0.310	0.690		
Ft Hood	380	Div Hq & Opns Bldg	141	0.5			0.033	0.033			0.100	0.267	0.100	0.467		
Korea	650	Mono Buoy System-Pohang	163	1.0					0.059	0.029					0.265	0.647
Ft Eustis	303	Gen Instruct Bldg Addn	171	0.5							0.264	0.238	0.025	0.090	0.212	0.171
Germany	923	Gen Hq & Clasrms-Bamberg	171	0.9	0.063						0.625	0.313				
Germany	391	Simul City Mout-Hohenfels	179	1.0	0.111						0.611	0.278				
Germany	594	Subcal Tank Rg-Bad Hers	179	1.0	0.031						0.688	0.281				
Germany	931	Surv Test Range-Weilerbach	179	0.9	0.033						0.667	0.300				
Ft Riley	117	Acft Mnt Hangar Shop Addn	211	1.0							0.500	0.500				
Loc 177	029	Aircraft Maint Hangar	211	1.0					0.081	0.027					0.649	0.243
Schofld Bks	103	Aircraft Hangar-Wheeler	211	0.9											0.510	0.490
Kwajalein	222	Rkt Assem Bldg-Roi Namur	212	1.0							0.146	0.293	0.073	0.146	0.086	0.256
Kwajalein	217	Marine Shop	213	0.9							0.158	0.283	0.060	0.158	0.060	0.283
Ft Benning	342	Tactical Equip Shops	214	0.9							0.281	0.259	0.107	0.044	0.202	0.107
Ft Hood	358	Tact Equip Shop	214	0.9							0.446	0.244	0.175	0.105	0.031	
Germany	423	Maint Facs Mod-Hohenfels	214	0.9	0.053						0.708	0.239				
Germany	600	Tac Eq Shop-Bremerhaven	214	1.0	0.053						0.708	0.239				
Germany	924	Vehicle Maint Shop-Bamberg	214	0.9	0.080						0.679	0.241				
Korea	690	Tact Equip Shop-Taegu	214	0.9					0.076						0.581	0.342
Germany	339	Surveil & Maint Fac-Miesau	216	0.9	0.032						0.581	0.387				
Germany	939	Ammo Surv Bldg-Vilseck	216	0.7	0.028						0.642	0.330				
Germany	940	Forklift Chrg Sta-Various	218	0.9	0.078						0.609	0.313				
Wtrvlt Ars	047	Facilities Mod Ph 3	225	1.0							0.262	0.246	0.111	0.053	0.170	0.158
Aber Pr Gr.	286	Kinetic Energy Launch Sys	310	0.9							0.285	0.299	0.028		0.221	0.167
Coldreg Lab	008	Frost Effects Res Fac	310	0.5							0.156	0.242	0.111	0.167	0.108	0.216
Ft Monmouth	140	Modernize R&D Bldg	310	0.4							0.197	0.197	0.145	0.145	0.158	0.158
Korea	689	Pol Pipeline Stg-Kunsan	411	0.9											0.529	0.471
Japan	176	Ammo Stg Fac Kawakami	421	0.8											0.556	0.444
Germany	277	Basic Load Site-Hanau	422	0.9							0.797	0.203				
Germany	414	Igloo Stg-Various	422	1.0							0.714	0.286				
				r_i	b_1	b_2	b_3	b_4	b_5	b_6	b_7	b_8	b_9	b_{10}	b_{11}	b_{12}

Figure 11. Median value of project relevance to readiness and normalized median values of project relevance to readiness subobjectives.

Location	Project Number	Description	Category	Rel. to FR	DISTRIBUTION OF PROJECT BENEFITS AMONG SUBOBJECTIVES FOR ARMY MISSION: BE READY TO WIN LAND BATTLES IN:											
					Present Conflicts (Within 5 Years)						Future Conflicts (After 5 Years)					
					T/O EUR		T/O USA		T/O OTH		T/O EUR		T/O USA		T/O OTH	
					INIT	SUST	INIT	SUST	INIT	SUST	INIT	SUST	INIT	SUST	INIT	SUST
Kwajalein	218	Live Explosive Storage Fac	422	0.9								0.359		0.210	0.144	0.287
Coldreg Lab	006	Vehicle Storage Bldg	441	0.4							0.158	0.149	0.065	0.389	0.189	0.050
Turkey	204	Sup Office/Whse-Det 67/168	441	0.7							0.594	0.406				
Redriver Ad	070	Add & Alt Depot Opms Bldg	442	0.5							0.077	0.462	0.077	0.205	0.064	0.115
Turkey	206	Dispensary-Det 67/168	550	1.0	0.054						0.514	0.432				
Ft Leaven	075	Renovate Admin Bldg	610	0.2							0.103	0.276	0.207	0.310	0.069	0.034
Rk Isl Ars	081	Alt Bldgs for Hq Fac-Ph II	610	0.4							0.178	0.238	0.178	0.238	0.109	0.059
Turkey	203	Admin Bldg-Det 67/168	610	0.7							0.526	0.474				
Turkey	302	Admin Bldg-Det 74	610	0.7							0.526	0.474				
Turkey	402	Admin Bldg-Det 155	610	0.7							0.526	0.474				
Ft Detrick	172	Barracks Modernization	721	0.7							0.151	0.170	0.094	0.132	0.075	0.377
Germany	798	Barracks W/Facs-Bamberg	721	0.9							0.717	0.283				
Korea	701	Barracks-Yongsan	721	0.8											0.738	0.262
Turkey	201	Barracks W/Dng-Det 67/168	721	0.9	0.054						0.541	0.405				
Turkey	301	Barracks-Det 74	721	0.9	0.054						0.541	0.405				
Turkey	401	Barracks-Det 155	721	0.9	0.054						0.541	0.405				
Germany	925	Dining Facility-Bamberg	722	0.9	0.059						0.706	0.235				
Ft Myer	112	Alter Barracks	723	0.7									0.474	0.526		
Germany	784	Banking Fac-Frankfurt	740	0.1							1.000					
Turkey	205	Cmunity Act Fac-Det 67/168	740	0.7							0.556	0.444				
Turkey	303	Cmunity Act Fac-Det 74	740	0.7							0.556	0.444				
Turkey	403	Cmunity Act Fac-Det 155	740	0.7							0.556	0.444				
Pres San Fr	110	Emerg Generator	811	0.8									0.396	0.604		
Not Bayonne	052	Exterior Lighting	812	0.8							0.182	0.818				
Turkey	207	Utilities Upgrd-Det 67/168	812	0.8	0.054						0.541	0.405				
Loc 276	140	Water Purification Plant	831	1.0							0.600	0.400				
Loc 276	136	Hvac Upgrade	890	1.0							0.625	0.375				
USMA	123	Improve Utility Systems	890	0.5							0.130	0.260	0.091	0.260		0.260
Ft Carson	281	Land Acquisition	911	1.0							0.281	0.281	0.125	0.125	0.063	0.125
				r_j	b_1	b_2	b_3	b_4	b_5	b_6	b_7	b_8	b_9	b_{10}	b_{11}	b_{12}

Figure 11. (Cont'd).

Facility Group	Subobjective	Description of Maximum Contribution Project
Group A	P-E-I	Air Defense Command Center in Europe
(Operations; Training;	P-U-I	BMD site in United States
Research, Development,	P-U-S	Tactical Satellite Commo Facility
and Test Facilities)	P-O-I	Intelligence gathering site
	P-O-S	Aerial/sea ports; POL lines
	F-E-I	Air Defense Command Center
	F-E-S	Anti-armor training ranges
	F-U-I	Renovate BMD facilities
	F-U-S	Renovate Tac Satellite Commo Facility
	F-O-I	Staging areas
	F-O-S	Aerial/sea ports; POL lines
Group B	P-E-I	Tactical equipment shop (Germany)
(Maintenance and	P-O-I	Tactical equipment shop
Production Facilities)	P-O-S	Depot maintenance and/or production
	F-E-I	DS/GS maintenance facility in Germany
	F-E-S	Depot maintenance and/or production
	F-U-I	Tactical equipment shop (Civil Defense)
	F-U-S	Tactical equipment shop (Civil Defense)
	F-O-I	DS/GS maintenance facility
	F-O-S	Depot maintenance and/or production
Group C	F-E-I	WRS storage sites
(Supply and	F-E-S	Depot storage
Administration	F-U-I	WRS storage sites
Facilities)	F-U-S	Depot storage
	F-O-I	WRS storage sites
	F-O-S	Depot storage
Group D	P-E-I	Hospitals
(Hospital, Medical,	F-E-I	Hospitals
Housing and Community	F-E-S	Hospitals
Facilities)	F-U-I	Hospitals
	F-U-S	Hospitals
	F-O-I	Hospitals
	F-O-S	Hospitals
Group E	P-E-I	Utilities (all)
(Utilities and Grounds	F-E-I	Utilities (all)
Improvements and Real	F-E-S	Port utilities
Estate)	F-U-I	Emergency power
	F-U-S	Emergency power
	F-O-I	Utilities (all)
	F-O-S	Utilities (all)

Figure 12. Initial working definitions of maximum contribution projects.

Location	Project Number	Description	Category	FOR ARMY MISSION: BE READY TO WIN LAND BATTLES IN:											
				Present Conflicts (Within 5 Years)						Future Conflicts (After 5 Years)					
				T/O EUR		T/O USA		T/O OTH		T/O EUR		T/O USA		T/O OTH	
				INIT	SUST	INIT	SUST	INIT	SUST	INIT	SUST	INIT	SUST	INIT	SUST
Total Worth of Maximum Contribution Project, per subobjective: a_i =				20.41	8.16	5.72	3.81	19.05	9.52	12.12	4.54	3.09	2.47	8.33	2.78
Korea	654	Airfld Fac Upgrade-Cp Hump	111					1.000						0.900	0.900
Okinawa	712	Pol Line Modifications-Var	125					0.800						0.900	0.900
Ft Campbell	252	CIDC Field Operations Bldg	141									0.150	0.200		
Ft Hood	380	Div Hq & Opns Bldg	141			0.200	0.300			0.240	0.280	0.300	0.300		
Korea	650	Mono Buoy System-Pohang	163					0.800	0.900					0.800	0.900
Ft Eustis	303	Gen Instruc Bldg Addn	171							0.300	0.300	0.300	0.300	0.800	0.500
Germany	923	Bn Hq & Clasrms-Bamberg	171	0.400						0.480	0.400				
Germany	391	Simul City Mount-Hohenfels	179	0.800						0.700	0.780				
Germany	594	Subcal Tank Rg-Bad Hers	179	0.800						0.700	0.830				
Germany	931	Surv Test Range-Weilerback	179	0.450						0.500	0.450				
Ft Riley	117	Acft Mnt Hangar Shop Addn	211							0.750	0.700				
Loc 177	029	Aircraft Maint Hangar	211					0.900	0.800					0.930	0.750
Schofld Bks	103	Aircraft Hangar-Wheeler	211											0.900	0.850
Kwajalein	222	Rkt Assem Bldg-Roi Namur	212							0.650	0.580	0.280	0.300	0.700	0.760
Kwajalein	217	Marine Shop	213							0.600	0.400	0.200	0.360	0.730	0.800
Ft Benning	342	Tactical Equip Shops	214							0.730	0.500	0.830	0.900	0.600	0.600
Ft Hood	358	Tact Equip Shop	214							0.800	0.500	0.830	0.900	0.550	
Germany	423	Maint Facs Mod-Hohenfels	214	0.900						0.900	0.800				
Germany	600	Tac Eq Shop-Bremerhaven	214	0.900						0.900	0.850				
Germany	924	Vehicle Maint Shop-Bamberg	214	0.900						0.900	0.800				
Korea	690	Tact Equip Shop-Taegu	214					1.000						0.900	0.900
Germany	339	Surveil & Maint Fac-Miesau	216	0.650						0.800	0.600				
Germany	939	Ammo Surv Bldg-Vilseck	216	0.600						0.630	0.500				
Germany	940	Forklift Chrg Sta-Various	218	0.500						0.580	0.400				
Wtrvlt Ars	047	Facilities Mod Ph 3	225							0.710	0.800	0.400	0.500	0.500	0.800
Aber Pr Gr	286	Kinetic Energy Launch Sys	310							0.800	0.830	0.280		0.500	0.300
Coldreg Lab	008	Frost Effects Res Fac	310							0.700	0.740	0.200	0.430	0.280	0.230
Ft Monmouth	140	Modernize R&D Bldg	310							0.380	0.450	0.200	0.380	0.200	0.300
Korea	689	Pol Pipeline Stg-Kunsan	411											0.800	0.950
Japan	176	Ammo Stg Fac Kawakami	421											0.800	0.900
Germany	277	Basic Load Site-Hanau	422							1.000	0.800				
Germany	414	Igloo Stg-Various	422							1.000	0.800				
				w_1	w_2	w_3	w_4	w_5	w_6	w_7	w_8	w_9	w_{10}	w_{11}	w_{12}

Figure 13. Median estimates of relative project worths within each subobjective.

Location	Project Number	Description	Category	FOR ARMY MISSION: BE READY TO WIN LAND BATTLES IN:											
				Present Conflicts (Within 5 Years)						Future Conflicts (After 5 Years)					
				T/O EUR		T/O USA		T/O OTH		T/O EUR		T/O USA		T/O OTH	
				INIT	SUST	INIT	SUST	INIT	SUST	INIT	SUST	INIT	SUST	INIT	SUST
Total Worth of Maximum Contribution Project, per subobjective: a_i =				**20.41**	**8.16**	**5.72**	**3.81**	**19.05**	**9.52**	**12.12**	**4.54**	**3.09**	**2.47**	**8.33**	**2.78**
Kwajalein	218	Live Explosive Storage Fac	422								0.500		0.400	0.730	0.700
Coldreg Lab	006	Vehicle Storage Bldg	441							0.150	0.100	0.100	0.100	0.100	0.110
Turkey	204	Sup Office/Whse-Det 67/168	441							0.460	0.350				
Redriver AD	070	Add & Alt Depot Opns Bldg	442							0.350	0.775	0.500	0.500	0.310	0.680
Turkey	206	Dispensary-Det 67/168	550	0.800						0.713	0.488				
Ft Leaven	075	Renovate Admin Bldg	610							0.040	0.030	0.010	0.010	0.020	0.100
Rk Isl Ars	081	Alt Bldgs for Hq Fac-Ph II	610							0.100	0.130	0.160	0.450	0.030	0.500
Turkey	203	Admin Bldg-Det 67/168	610							0.310	0.130				
Turkey	302	Admin Bldg-Det 74	610							0.310	0.200				
Turkey	402	Admin Bldg-Det 155	610							0.310	0.200				
Ft Detrick	172	Barracks Modernization	721							0.430	0.400	0.500	0.430	0.330	0.330
Germany	798	Barracks W/Facs-Bamberg	721							0.530	0.450				
Korea	701	Barracks-Yongsan	721											0.760	0.380
Turkey	201	Barracks W/Dng-Det 67/168	721	0.500						0.530	0.500				
Turkey	301	Barracks-Det 74	721	0.500						0.530	0.500				
Turkey	401	Barracks-Det 155	721	0.500						0.530	0.500				
Germany	925	Dining Facility-Bamberg	722	0.430						0.500	0.440				
Ft Myer	112	Alter Barracks	723									0.380	0.200		
Germany	784	Banking Fac-Frankfurt	740							0.060					
Turkey	205	Cmunity Act Fac-Det 67/168	740							0.300	0.200				
Turkey	303	Cmunity Act Fac-Det 74	740							0.300	0.200				
Turkey	403	Cmunity Act Fac-Det 155	740							0.300	0.200				
Pres San Fr	110	Emerg Generator	811									1.000	1.000		
Mot Bayonne	052	Exterior Lighting	812							0.600	0.900				
Turkey	207	Utilities Upgrd-Det 67/168	812	1.000						0.850	0.750				
Loc 276	140	Water Purification Plant	831							0.800	0.850				
Loc 276	136	Hvac Upgrade	890							0.700	0.680				
USMA	123	Improve Utility Systems	890							0.150	0.110	0.460	0.490		0.230
Ft Carson	281	Land Acquisition	911							0.280	0.400	0.200	0.350	0.140	0.350
				w_1	w_2	w_3	w_4	w_5	w_6	w_7	w_8	w_9	w_{10}	w_{11}	w_{12}

Figure 13. (Cont'd).

Location	Project Number	Description	CAT	Subobjective Value (a_i)	×	Subobjective Relevance (b_i)	×	Relative Project Worth (w_i)	=	Project Subobjective (B_R/C_R)
Germany	414	Igloo Stg-Various	422	FEI: 12.12		0.714		1.000		8.65
				FES: 4.54		0.286		0.800		1.04
								Sum = Overall B_R/C_R:		9.69
Turkey	206	Dispensary-Det 67/168	550	PEI: 20.41		0.054		0.800		0.88
				FEI: 12.12		0.514		0.713		4.44
				FES: 4.54		0.432		0.488		0.96
								Sum = Overall B_R/C_R:		6.28
Wtrvlt Ars	047	Facilities Mod PH3	225	FEI: 12.12		0.262		0.710		2.25
				FES: 4.54		0.246		0.800		0.89
				FUI: 3.09		0.111		0.400		0.14
				FUS: 2.47		0.053		0.500		0.07
				FOI: 8.33		0.170		0.500		0.71
				FOS: 2.78		0.158		0.800		0.35
								Sum = Overall B_R/C_R:		4.41
Ft. Carson	281	Land Acquisition	911	FEI: 12.12		0.281		0.280		0.95
				FES: 4.54		0.281		0.400		0.51
				FUI: 3.09		0.125		0.200		0.08
				FUS: 2.47		0.125		0.350		0.11
				FOI: 8.33		0.063		0.140		0.07
				FOS: 2.78		0.125		0.350		0.12
								Sum = Overall B_R/C_R:		1.84
Ft. Monmouth	140	Modernize R&D Bldg	310	FEI: 12.12		0.380		0.197		0.90
				FES: 4.54		0.450		0.197		0.40
				FUI: 3.09		0.200		0.145		0.10
				FUS: 2.47		0.380		0.145		0.13
				FOI: 8.33		0.200		0.158		0.27
				FOS: 2.78		0.300		0.158		0.13
								Sum = Overall B_R/C_R:		1.93
Germany	784	Banking Fac-Frankfurt	740	FEI: 12.12		1.000		0.060		0.70

Figure 14. Examples of Step 7 calculations.

Location	Project Number	Project Description	CAT	B_R/C_R	Group Merge Factor
		Group A: (Base Group) Operations, Training, RD&T			
Ft. Campbell	252	CIDC Field Operations Bldg	141	0.3	
Ft. Hood	380	Div Hq & Opns Bldg	141	1.2	
Ft. Monmouth	140	Modernize R&D Bldg	310	1.9	
Coldreg Lab	008	Frost Effects Res Fac	310	2.8	
Ft. Eustis	303	Gen Instruct Bldg Addn	171	3.0	
Korea	650	Mono Buoy System-Pohang	163	4.5	f_A =
Germany	923	Bn Hq & Classrms-Bamberg	171	4.7	1.0
Germany	931	Surv Test Range-Weilerbach	179	5.0	
Aber Pr Gr	286	Kinetic Energy Launch Sys	310	5.0	
Okinawa	712	POL Line Modifications-Var	175	5.9	
Germany	594	Subcal Tank Rg-Bad Hers	179	7.4	
Korea	654	Airfld Fac Upgrade-Cp Hump	111	7.7	
Germany	391	Simul City Mout-Hohenfels	179	8.0	
		Group B: Maintenance and Production			
Kwajalein	217	Marine Shop	213	2.9	
Kwajalein	222	Rkt Assen Bldg-Roi Namur	212	3.1	
Wtrvlt Ars	047	Facilities mod Ph 3	225	4.4	
Ft. Benning	342	Tactial Equip Shops	214	4.7	
Schofld Bks	103	Aircraft Hangar-Wheeler	211	5.0	
Germany	940	Forklift Chrg Sta-Various	218	5.7	
Ft. Hood	358	Tact Equip Shop	214	5.7	f_B =
Germany	939	Ammo Surv Bldg-Vilseck	216	6.0	1.0
Ft. Riley	117	Acft Mnt Hangar Shop Addn	211	6.1	
Korea	690	Tact Equip Shop-Taegu	214	6.7	
Germany	339	Surveil & Maint Fac-Miesau	216	7.1	
Loc 177	029	Aircraft Maint Hangar	211	7.1	
Germany	423	Maint Facs Mod-Hohenfels	214	9.6	
Germany	600	Tac Equip Shp-Bremerhaven	214	9.6	
Germany	924	Vehicle Maint Shop-Bamberg	214	9.8	
		Group C: Supply & Administration			
Ft. Leaven	07›	Renovate Admin Bldg	610	0.1	
Coldreg Lab	006	Vehicle Storage Bldg	441	0.8	
Rk Isl Ars	081	Alt Bldgs for Hq Fac-Ph II	610	0.8	
Turkey	203	Admin Bldg-Det 67/168	610	2.3	
Turkey	302	Admin Bldg-Det 74	610	2.4	
Turkey	402	Admin Bldg-Det 155	610	2.4	f_C =
Kwajalein	218	Live Explosive Storage Fac	422	2.4	1.0
Redriver Ad	070	Add & Alt Depot Opns Bldg	442	2.8	
Turkey	204	Sup Office/Whse-Det 67/168	441	4.3	
Korea	689	POL Pipeline Stg-Kunsaw	411	4.8	
Japan	176	Ammo Stg Fac Kawakami	421	4.9	
Germany	414	Igloo Stg - Various	422	9.7	
Germany	277	Basic Load Site - Hanau	422	10.4	
		Group D: Hospital, Medical, Housing, Community			
Germany	784	Banking Fac-Frankfurt	740	0.7	
Ft. Myer	112	Alter Barracks	723	0.9	
Ft. Detrick	172	Barracks Modernization	721	2.0	
Turkey	303	Community Act Fac-Det 74	740	2.4	
Turkey	403	Community Act Fac-Det 155	740	2.4	
Turkey	205	Cmunity Act Fac-Det 67/168	740	2.4	f_D =
Korea	701	Barracks-Yongsan	721	5.0	0.9
Turkey	401	Barracks-Det 155	721	5.0	
Turkey	301	Barracks-Det 74	721	5.0	
Turkey	201	Barracks W/Dng-Det 67/168	721	5.0	
Germany	798	Barracks W/Facs-Bamberg	721	5.2	
Germany	925	Dining Facility-Bamberg	722	5.2	
Turkey	206	Dispensary-Det 67/168	550	6.3	
		Group E: Utilities, Grounds, Real Estate			
USMA	123	Improve Utility Systems	890	1.0	
Ft. Carson	281	Land Acquisition	911	1.9	
Pres San Fr	110	Emerg Generator	811	2.8	f_E =
Mot Bayonne	052	Exterior Lighting	812	4.6	1.0
Loc 276	136	HVAC Upgrade	890	6.5	
Loc 276	140	Water Purification Plant	831	7.4	
Turkey	207	Utilities Upgrd-Det 67/168	812	8.0	

Figure 15. Group merge factors used in Step 8.

Location	Project Number	Description	CAT	B_R/C_R	X	Group Adjust Factor (f_j)	X	C_R/C_T (r)	=	B_R/C_T
Germany	414	Igloo Stg-Various	422	9.69		1.0		1.0	=	9.7
Turkey	206	Dispensary-Cnet 67/168	550	6.28		0.9		1.0	=	5.7
Wtrvlt Ars	047	Facilities Mod PH3	225	4.41		1.0		1.0	=	4.4
Ft. Carson	281	Land Acquisition	911	1.84		1.0		1.0	=	1.8
Ft. Monmouth	140	Modernize R&D Bldg	310	1.93		1.0		0.4	=	0.8
Germany	784	Banking Fac-Frankfurt	740	0.70		0.9		0.1	=	0.1

Figure 16. Examples of Step 9 calculations.

were used as in the field test to show a project's relevance to force readiness. However, the b values, which show how much a project contributes to each mission subobjective, were determined by using the field test values *only* on the "Future Conflicts" side of Figure 11. Then, where necessary, those values were factored upward so the sum of the b values for each project was equal to 100. The results are shown in Figure 22. No new maximum contribution projects were defined. Rather, it was assumed that the project worths were the same under the new grouping scheme as they were under the grouping scheme used in the field test. However, only project worth values on the "Future Conflict" side of Figure 13 were used. These values are shown in Figure 23. The computational process used to determine the intermediate B_R/C_R ratio is the same as that described in Chapter 3, except there are no "Present Conflict" entries. The adjustment factors shown in Figure 24 were derived by regrouping the projects and assigning them, where possible, the same factor as generated in the field test. This was possible in all cases except those projects for which the Corps of Engineers was proponent. Seven of the Corps projects had field test merge factors of 1.0; eight had field test merge factors of 0.9. The 0.9 value was used for the analysis. Although the single project in The Surgeon General's (TSG's) group had a field test factor of 0.9, this was probably due to being grouped with housing and community projects. Under the new grouping scheme, it is likely that its merge factor would also have been 1. Regardless, the 0.9 value was used in this analysis. Note there is only a 10 percent spread in the merge factor values. This is not surprising since facilities are functionally a fairly homogeneous group when compared to total defense needs. The real utility of the merge factor would be in determining the relative worth of procuring main battle tanks, to procuring Research and Development, to procuring Military Construction, etc.

Results of Revising the Pilot Model

The final results of the revised model, shown in the "new ranks" column of Figure 25, were compared with the field test results by showing the "old rank" for each project as determined in the field test. Only two projects ranks changed significantly; the POL Line Modifications project in Okinawa dropped in rank from 19 to 30, and the Mono Buoy System in Pohang, Korea, dropped in rank from 20 to 34. A glance at Figures 9 and 11 explains why. In the field test, both projects were rated as contributing a significant portion of their overall worth to winning the "Initial Battle" in "Other Theaters" in "Present Day Conflicts." That particular mission node had a weight of 19.05, the second highest mission node weight. When the present side of the mission tree was eliminated, that benefit stream was shifted to the "Future Conflict" side of the mission tree which had mission weights (relative to 19.05) of 8.33 and 2.78. Although the highest B_R/C_T ratio jumped from 9.7 to 29.1, this has no significance in itself since the B/C scale is relative and can be factored up or down without changing the relative value of one project to another. However, comparing the ratio of the sixteenth (first quartile) project's B/C ratio and the forty-eighth

Location	Project Number	Project Description	CAT	PRO	MACOM	C_T = SPA($K)	B_R/C_T	Facilities Readiness Rank
Germany	414	Igloo Stg-Various	422	LOG	USAREUR	1,700	9.7	1
Germany	600	Tac. Eq. Shop-Bremerhaven	214	LOG	USAREUR	2,050	9.6	2
Germany	277	Basic Load Site-Hansu	422	LOG	USAREUR	2,700	9.4	3
Germany	924	Vehicle Maint Shop-Bamberg	214	LOG	USAREUR	7,900	8.8	4
Germany	423	Maint Facs Mod-Hohenfels	214	LOG	USAREUR	4,000	8.6	5
Germany	391	Simul City Mout-Hohenfels	179	OPS	USAREUR	4,450	8.0	6
Germany	594	Subcal Tank RG-Bad Hers	179	OPS	USAREUR	1,200	7.4	7
Loc 276	140	Water Purification Plant	831	OCE	INSCOM	5,400	7.4	8
Loc 177	029	Aircraft Maint Hangar	211	LOG	INSCOM	1,100	7.1	9
Korea	654	Airfld Fac Upgrade-CP Hump	111	OPS	EUSA	6,100	6.9	10
Loc 276	136	HVAC Upgrade	890	OCE	INSCOM	700	6.5	11
Turkey	207	Utilities Upgrd-Det 67/168	812	OCE	USAREUR	510	6.4	12
Germany	339	Surveil & Maint Fac-Miesau	216	LOG	USAREUR	7,000	6.4	13
Ft. Riley	117	Acft Mnt Hangar Shop Addn	211	LOG	FORSCOM	1,350	6.1	14
Korea	690	Tact Equip Shop-Taegu	214	LOG	EUSA	1,000	6.0	15
Turkey	206	Dispensary-DET 67/168	550	TSG	USAREUR	510	5.7	16
Ft. Hood	358	Tact Equip Shop	214	LOG	FORSCOM	7,300	5.1	17
Germany	940	Forklift Chrg Sta-Various	218	LOG	USAREUR	530	5.1	18
Okinawa	712	Pol Line Modifications-Var	125	LOG	USARJ	610	4.7	19
Korea	650	Mono Buoy System-Pohang	163	LOG	EUSA	350	4.5	20
Aber Pr Gr	286	Kinetic Energy Launch Sys	310	RDA	DARCOM	2,800	4.5	21
Germany	931	Surv Test Range-Weilerbach	179	OPS	USAREUR	350	4.5	22
Schofld Bks	103	Aircraft Hangar-Wheeler	211	LOG	WESTCOM	9,900	4.5	23
Wtrvlt Ars	047	Facilities Mod Ph 3	225	RDA	DARCOM	10,400	4.4	24
Korea	689	Pol Pipeline Stg-Kunsan	411	LOG	EUSA	4,750	4.3	25
Germany	925	Dining Facility-Bamberg	722	LOG	USAREUR	2,850	4.3	26
Germany	923	Bn Hq & Clasrms-Bamberg	171	PER	USAREUR	1,250	4.2	27
Germany	798	Barracks W/Facs-Bamberg	721	PER	USAREUR	20,000	4.2	28
Ft. Benning	342	Tactical Equip Shops	214	LOG	TRADOC	4,150	4.2	29
Germany	939	Ammo Surv Bldg-Vilseck	216	LOG	USAREUR	410	4.2	30
Turkey	201	Barracks w/Dng-Det 67/168	721	PER	USAREUR	4,000	4.0	31
Turkey	301	Barracks-Det 74	721	PER	USAREUR	1,900	4.0	32
Turkey	401	Barracks-Det 155	721	PER	USAREUR	1,900	4.0	33
Japan	176	Ammo Stg Fac Kawakami	421	LOG	USARJ	1,950	3.9	34
Mot Bayonne	052	Exterior Lighting	812	OCE	MTMC	240	3.7	35
Korea	701	Barracks-Yongsan	721	PER	EUSA	3,400	3.6	36
Kwajalein	222	Rkt Assem Bldg-Roi Namur	212	LOG	BMDSC	1,200	3.1	37
Turkey	204	Sup Office/Whse-Det 67/168	441	LOG	USAREUR	1,000	3.0	38
Kwajalein	217	Marine Shop	213	LOG	BMDSC	1,600	2.6	39
Kwajalein	218	Live Explosive Storage Fac	422	LOG	BMDSC	550	2.2	40
Pres San Fr	110	Emerg Generator	811	TSG	FORSCOM	790	2.2	41
Ft. Carson	281	Land Acquisition	911	OCE	FORSCOM	26,000	1.8	42
Turkey	402	Admin Bldg-Det 155	610	PER	USAREUR	900	1.7	43
Turkey	302	Admin Bldg-Det 74	610	PER	USAREUR	750	1.7	44
Turkey	203	Admin Bldg-Det 67/168	610	PER	USAREUR	1,300	1.6	45
Turkey	205	Cmunity Act Fac-Det 67/168	740	TAG	USAREUR	1,100	1.5	46
Turkey	403	Community Act Fac-Det 155	740	TAG	USAREUR	600	1.5	47
Turkey	303	Community Act Fac-Det 74	740	TAG	USAREUR	520	1.5	48
Ft. Eustis	303	Gen Instruct Bldg Addn	171	OPS	TRADOC	3,850	1.5	49
Redriver Ad	070	Add & Alt Depot Opns Bldg	442	LOG	DARCOM	1,900	1.4	50
Coldreg Lab	008	Frost Effects Res Fac	310	RDA	ENGRS	6,900	1.4	51
Ft. Detrick	172	Barracks Modernization	721	PER	HSC	1,450	1.2	52
Ft. Monmouth	140	Modernize R&D Bldg	310	RDA	DARCOM	20,000	0.8	53
Ft. Hood	380	Div Hq Opns Bldg	141	PER	FORSCOM	9,700	0.6	54
Ft. Myer	112	Alter Barracks	723	PER	MDW	840	0.5	55
USMA	123	Improve Utility Systems	890	OCE	USMA	3,150	0.5	56
Rk Isl Ars	081	Alt Bldgs for Hq Fac-Ph II	610	LOG	DARCOM	7,400	0.3	57
Coldreg Lab	006	Vehicle Storage Bldg	441	LOG	ENGRS	180	0.3	58
Ft. Campbell	252	CIDC Field Operations Bldg	141	PER	CIDC	1,150	0.1	59
Germany	784	Banking Fac-Frankfurt	740	TAG	USAREUR	480	0.1	60
Ft. Leaven	075	Renovate Admin Bldg	610	PER	TRADOC	7,200	0.0	61
					TOTAL:	$227,220		

Figure 17. Facility projects arranged by force readiness benefit/total cost ratio.

Time Required by CRRC (Hours)	Activity Description
1/3	Define Force Readiness
2/3	Define Mission Hierarchy
1-1/4	Weight Mission Hierarchy (2 passes)
1/4	Group Facility Projects
2-1/4	Decide Project Relevance to Readiness (2 passes)
3-1/4	Decide Project Relevance to Missions (2 passes)
2	Define Standards
2-1/2	Decide Relative Project Worths (2 passes)
0	Compute B_R/C_R
2	Decide Merger Factors (2 passes)
0	Compute $B_R/C_{\$PA}$
1-1/2	Review Results
16 Total	

Figure 18. Times required to conduct each step of the field test.

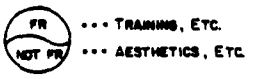
(third quartile) project's B/C ratio for both old and new models shows how the relative shape of the B/C ratio distribution changed. The old ratio is 5.7/1.5 = 3.8; the new ratio is 15.4/4.6 = 3.35. Using 3.8 as a reference base, 3.35 represents a 12 percent decrease in the spread of the distribution. Thus, it may be concluded that using six instead of 12 mission objectives causes the model to lose some sensitivity and to be about 12 percent less discriminatory. However, this loss might well be offset if the raters gave more careful attention to fewer rating factors.

Manual Model Description

By December 1980, the Army had decided to support an evaluation process tied directly to the Army's Mission Area Analysis initiative. CERL, therefore, was directed to revise its model again so it could be used to determine the relative readiness contribution of a *few* marginal MCA projects. This manual version was designed to operate without mainframe computer support. A schematic of the general procedures for the manual version is shown in Figure 26. CERL has developed algorithms that can be used manually, or on programmable calculators, to derive model results without too much computational effort.[4]

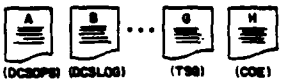
[4] John M. Deponai III, Laure Thomas, Craig Kukielski, and Joe Sheffield, *Facilities Readiness Quantification Model Users Manual*, Technical Report P-124 (U.S. Army Construction Engineering Research Laboratory [CERL], 1982).

1. DEFINE FORCE READINESS (FR):

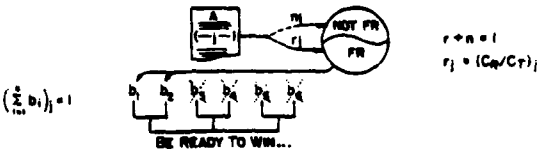


2. BREAK FR DOWN INTO NON-REDUNDANT, WEIGHTED SUB-OBJECTIVES:

3. GROUP FACILITY PROJECTS:

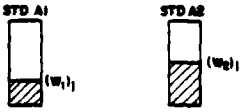


4. DECIDE EACH PROJECT'S RELEVANCE TO FR AND TO FR SUB-OBJECTIVES:



5. DEFINE MAX CONTRIBUTION PROJECTS AS STANDARDS:

6. COMPARE PROJECT WORTHS TO APPROPRIATE STANDARDS:



7. COMPUTE EACH PROJECT'S INTERMEDIATE B_R/C_R:

$$\left(\sum_{i=1}^{6} a_i b_i w_i\right)_j = (B_R/C_R)_j$$

8. MERGE B_R/C_R RATIOS IN EACH GROUP TO COMMON BASE:

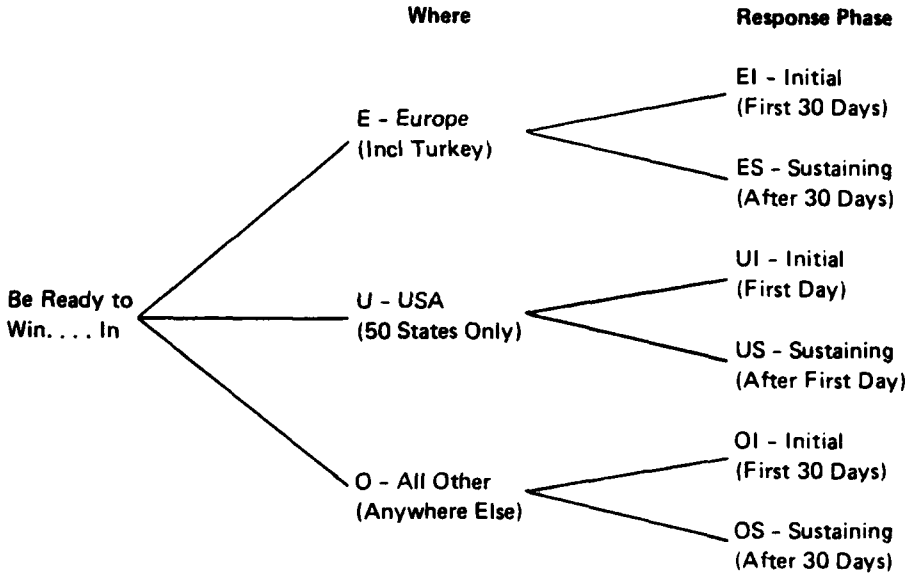
9. COMPUTE FINAL B_R/C_T FOR EACH PROJECT:

$$(B_R/C_R)_j \times f_j \times r_j = (B_R/C_T)_j = (B_R/\$PA)_j$$

10. REVIEW AND DISCUSS RESULTS:

RANK	B/C
1	28.1
2	28.1
3	27.4
⋮	⋮

Figure 19. Revised model procedures (Version 2).



- MISSION SIGNIFICANCE RATIOS -		
EUR/USA = 3.00		OTH/USA = 2.00
I/S = 2.67 (EUR)	I/S = 1.25 (USA)	I/S = 3.00 (OTH)

- DISTRIBUTION OF 100 READINESS UTILES -

100.00 BE READY TO WIN . . .

50.00 In Europe		16.67 In USA		33.33 In OTHER	
36.38 INITIAL (a_1)	13.62 SUSTAIN (a_2)	9.26 INITIAL (a_3)	7.41 SUSTAIN (a_4)	25.00 INITIAL (a_5)	8.33 SUSTAIN (a_6)

Figure 20. Simplified hierarchy, mission significance ratios, and resulting mission weights.

Investment Categories	Group-Proponent	AR 415-28 Facility Classes
	Group A-DCSOPS	
Operations & Commo		123, 126, 137, 141-143, 148, 149
Aviation Operations		111-113, 116, 121
Training		171, 179
	Group B-DCSLOG	
Maintenance		211-219
Waterfront & Harbor		122, 151-155, 159, 161-165, 169
POL Supply/Storage		124, 125, 411, 412
Ammo & Other Supply/Storage		400 Series
	Group C-DCSPER	
Administration		600 Series
	Group D-DCSRDA	
RDT&E		300 Series
Production		221-229
	Group E-ACSAC	
Operations & Commo		131, 132, 135, 138
Aviation Operations		133, 134, 136
	Group F-TAG	
Community		730, 740, 750, 760
	Group G-TSG	
Hospital/Medical		500 Series
	Group H-COE	
Family Housing		711-714
Bachelor Housing		721, 723-725
Utilities, Roads/Grounds		800 Series
Real Estate		900 Series

Figure 21. Revised project grouping scheme.

Location	Project Number	Description	Cat	Relevance to Force Readiness	For Army Mission: Be Ready to Win Land Battles In: T/O EUR I(b_1)	T/O EUR S(b_2)	T/O USA I(b_3)	T/O USA S(b_4)	T/O OTH I(b_5)	T/O OTH S(b_6)
Korea	654	Airfld Fac Upgrade-CP Hump	111	0.9					0.778	0.222
Okinawa	712	POL Line Modifications-Var	125	0.8					0.462	0.538
Ft. Campbell	252	CIDC Field Operations Bldg	141	0.3			0.310	0.690		
Ft. Hood	380	Div Hq & Opns Bldg	141	0.5	0.107	0.286	0.107	0.500		
Korea	650	Mono Buoy System-Pohang	163	1.0					0.291	0.709
Ft. Eustis	303	Gen Instruct Bldg Addn	171	0.5	0.264	0.238	0.025	0.090	0.212	0.171
Germany	923	Bn Hq & Classrms-Bamberg	171	0.9	0.667	0.333				
Germany	391	Simul City Mount-Hohenfels	179	1.0	0.687	0.313				
Germany	594	Subcal Tank Rg-Bad Hers	179	1.0	0.710	0.290				
Germany	931	Surv Test Range-Weilerbach	179	0.9	0.690	0.310				
Ft. Riley	117	Acft Mnt Hangar Shop Addn	211	1.0	0.500	0.500				
Loc 177	029	Aircraft Maint Hangar	211	1.0					0.728	0.272
Schfld Bks	103	Aircraft Hangar-Wheeler	211	0.9					0.510	0.490
Kwajalein	222	Rkt Assem Bldg-ROI Namur	212	1.0	0.146	0.293	0.073	0.146	0.086	0.256
Kwajalein	217	Marine Shop	213	0.9	0.158	0.283	0.060	0.158	0.060	0.283
Ft. Benning	342	Tactical Equip Shops	214	0.9	0.281	0.259	0.107	0.044	0.202	0.107
Ft. Hood	358	Tact Equip Shop	214	0.9	0.446	0.244	0.175	0.105	0.031	
Germany	423	Maint Facs Mod-Hohenfels	214	0.9	0.748	0.252				
Germany	600	Tac Eq Shop-Bremerhaven	214	1.0	0.748	0.252				
Germany	924	Vehicle Maint Shop-Bamberg	214	0.9	0.738	0.262				
Korea	690	Tact Equip Shop-Taegu	214	0.9					0.629	0.371
Germany	339	Surveil & Maint Fac-Miesau	216	0.9	0.600	0.400				
Germany	939	Ammo Surv Bldg-Vilseck	216	0.7	0.660	0.340				
Germany	940	Forklift Chrg Sta-Various	218	0.9	0.661	0.339				
Wtrvlt Ars	047	Facilities Mod Ph 3	225	1.0	0.262	0.246	0.111	0.053	0.170	0.158
Aber Pr Gr	286	Kinetic Energy Launch Sys	310	0.9	0.285	0.299	0.028		0.221	0.167
Coldreg Lab	008	Frost Effect Res Fac	310	0.5	0.156	0.242	0.111	0.167	0.108	0.216
Ft. Monmouth	140	Modernize R&D Bldg	310	0.4	0.197	0.197	0.145	0.145	0.158	0.158
Korea	689	POL Pipeline Stg-Kunsan	411	0.9					0.529	0.471
Japan	176	Ammo Stg Fac-Kawakami	421	0.8					0.556	0.444
Germany	277	Basic Load Site-Hanau	422	0.9	0.797	0.203				
Germany	414	Igloo Stg-Various	422	1.0	0.714	0.286				
Kwajalein	218	Live Explosive Storage Fac	422	0.9		0.359		0.210	0.144	0.287
Coldreg Lab	006	Vehicle Storage Bldg	441	0.4	0.158	0.149	0.065	0.389	0.189	0.050
Turkey	204	Sup Office/Whse-Det 67/168	441	0.7	0.594	0.406				
Redriver Ad	070	Add & Adt Depot Opns Bldg	442	0.5	0.077	0.462	0.077	0.205	0.064	0.115
Turkey	206	Dispensary-Det 67/168	550	1.0	0.543	0.457				
Ft. Leaven	075	Renovate Admin Bldg	610	0.2	0.103	0.276	0.207	0.310	0.069	0.034
Rk Isl Ars	081	Alt Bldgs For Hq Fac-Ph II	610	0.4	0.178	0.238	0.178	0.238	0.109	0.059
Turkey	203	Admin Bldg-Det 67/168	610	0.7	0.526	0.474				
Turkey	302	Admin Bldg-Det 74	610	0.7	0.526	0.474				
Turkey	402	Admin Bldg-Det 155	610	0.7	0.526	0.474				
Ft. Detrick	172	Barracks Modernization	721	0.7	0.151	0.170	0.094	0.132	0.075	0.377
Germany	798	Barracks w/Facs-Bamberg	721	0.9	0.717	0.283				
Korea	701	Barracks-Yongsan	721	0.8					0.738	0.262
Turkey	201	Barracks w/Dng-Det 67/168	721	0.9	0.572	0.428				
Turkey	301	Barracks-Det 74	721	0.9	0.572	0.428				
Turkey	401	Barracks-Det 155	721	0.9	0.572	0.428				
Germany	925	Dining Facility-Bamberg	722	0.9	0.750	0.25				
Ft. Myer	112	Alter Barracks	723	0.7			0.474	0.526		
Germany	784	Banking Fac-Frankfurt	740	0.1	1.00					
Turkey	205	Comunity Act Fac-Det 67/168	740	0.7	0.556	0.444				
Turkey	303	Community Act Fac-Det 74	740	0.7	0.556	0.444				
Turkey	403	Community Act Fac-Det 155	740	0.7	0.556	0.444				
Pres San Fr	110	Emerg Generator	811	0.8			0.396	0.604		
Mot Bayonne	052	Exterior Lighting	812	0.8	0.182	0.818				
Turkey	207	Utilities Upgrd-Det 67/168	812	0.8	0.572	0.428				
Loc 276	140	Water Purification Plant	831	1.0	0.600	0.400				
Loc 276	136	HVAC Upgrade	890	1.0	0.625	0.375				
USMA	123	Improve Utility Systems	890	0.5	0.130	0.260	0.091	0.260		0.260
Ft. Carson	281	Land Acquisition	911	1.0	0.281	0.281	0.125	0.125	0.063	0.125

Figure 22. Revised median values of project relevance to readiness and revised normalized median values of project relevance to readiness subobjectives.

Location	Project Number	Description	Cat	For Army Mission: Be Ready to Win Land Battles In: T/O EUR I(w_1)	S(w_2)	T/O USA I(w_3)	S(w_4)	T/O OTH I(w_5)	S(w_6)
Korea	654	Airfld Fac Upgrade-Cp Hump	111					0.900	0.900
Okinawa	712	POL Line Modifications-Var	125					0.900	0.900
Ft. Campbell	252	CIDC Field Operations Bldg	141			0.150	0.200		
Ft. Hood	380	Div Hq & Opns Bldg	141	0.240	0.280	0.300	0.300		
Korea	650	Mono Buoy System-Pohang	163					0.800	0.900
Ft. Eustis	303	Gen Instruct Bldg Addn	171	0.300	0.300	0.300	0.300	0.800	0.500
Germany	923	Bn Hq & Classrms-Bamberg	171	0.480	0.400				
Germany	391	Simul City Mount-Hohenfels	179	0.700	0.780				
Germany	594	Subcal Tank Rg-Bad Hers	179	0.700	0.830				
Germany	931	Surv Test Range-Weilerback	179	0.500	0.450				
Ft. Riley	117	Acft Mnt Hangar Shop Addn	211	0.750	0.700				
Loc 177	029	Aircraft Maint Hanger	211					0.930	0.750
Schofld Bks	103	Aircraft Hangar-Wheeler	211					0.900	0.850
Kwajalein	222	Rkt Assem Bldg-ROI Namur	212	0.650	0.580	0.280	0.300	0.700	0.760
Kwajalein	217	Marine Shop	213	0.600	0.400	0.200	0.360	0.730	0.800
Ft. Benning	342	Tactical Equip Shops	214	0.730	0.500	0.830	0.900	0.600	0.600
Ft. Hood	358	Tact Equip Shop	214	0.800	0.500	0.830	0.900	0.550	
Germany	423	Maint Facs Mod-Hohenfels	214	0.900	0.800				
Germany	600	Tac Eq Shop-Bremerhaven	214	0.900	0.850				
Germany	924	Vehicle Maint Shop-Bamberg	214	0.900	0.800				
Korea	690	Tact Equip Shop-Taegu	214					0.900	0.900
Germany	339	Surveil & Maint Fac-Miesau	216	0.800	0.600				
Germany	939	Ammo Surv Bldg-Vilseck	216	0.630	0.500				
Germany	940	Forklift Chrg Sta-Various	218	0.580	0.400				
Wtrvlt Ars	047	Facilities Mod Ph 3	225	0.710	0.800	0.400	0.500	0.500	0.800
Aber Pr Gr	286	Kinetic Energy Launch Sys	310	0.800	0.830	0.280		0.500	0.300
Coldreg Lab	008	Frost Effects Res Fac	310	0.700	0.740	0.200	0.430	0.280	0.230
Ft Monmouth	140	Modernize R&D Bldg	310	0.380	0.450	0.200	0.380	0.200	0.300
Korea	689	POL Pipeline Stg-Kunsan	411					0.800	0.950
Japan	176	Ammo Stg Fac-Kawakami	421					0.800	0.900
Germany	277	Basic Load Site-Hanau	422	1.000	0.800				
Germany	414	Igloo Stg-Various	422	1.000	0.800				
Kwajalein	218	Live Explosive Storage Fac	422		0.500		0.400	0.730	0.700
Coldreg Lab	006	Vehicle Storage Bldg	441	0.150	0.100	0.100	0.100	0.100	0.110
Turkey	204	Sup Office/Whse-Det 67/168	441	0.460	0.350				
Redriver Ad	070	Add & Alt Depot Opns Bldg	442	0.350	0.775	0.500	0.500	0.310	0.680
Turkey	206	Dispensary-Det 67/168	550	0.173	0.488				
Ft. Leaven	075	Renovate Admin Bldg	610	0.040	0.030	0.010	0.010	0.020	0.100
Rk Isl Ars	081	Alt Bldgs for Hq Fac-Ph II	610	0.100	0.130	0.160	0.450	0.030	0.500
Turkey	203	Admin Bldg-Det 67/168	610	0.310	0.130				
Turkey	302	Admin Bldg-Det 74	610	0.310	0.200				
Turkey	402	Admin Bldg-Det 155	610	0.310	0.200				
Ft. Detrick	172	Barracks Modernization	721	0.430	0.400	0.500	0.430	0.300	0.330
Germany	798	Barracks w/Facs-Bamberg	721	0.530	0.450				
Korea	701	Barracks-Yongsan	721					0.760	0.380
Turkey	201	Barracks w/Dng-Det 67/168	721	0.530	0.500				
Turkey	301	Barracks-Det 74	721	0.530	0.500				
Turkey	401	Barracks-Det 155	721	0.530	0.500				
Germany	925	Dining Facility-Bamberg	722	0.500	0.440				
Ft. Myer	112	Alter Barracks	723			0.380	0.200		
Germany	784	Banking Fac-Frankfurt	740	0.060					
Turkey	205	Cmunity Act Fac-Det 67/168	740	0.200					
Turkey	303	Community Act Fac-Det 74	740	0.300	0.200				
Turkey	403	Community Act Fac-Det 155	740	0.300	0.200				
Pres San Fr	110	Emerg Generator	811			1.000	1.000		
Mot Bayonne	052	Exterior Lighting	812	0.600	0.900				
Turkey	207	Utilities Upgrd-Det 67/168	812	0.850	0.750				
Loc 276	140	Water Purification Plant	831	0.800	0.850				
Loc 276	136	HVAC Upgrade	890	0.700	0.680				
USMA	123	Improve Utility Systems	890	0.150	0.110	0.460	0.490		0.230
Ft. Carson	281	Land Acquisition	911	0.280	0.400	0.200	0.350	0.140	0.350

Figure 23. Revised median estimates of relative project worths within each subobjective.

Group	Proponent	Number of Projects	Merge Factors
A	DCSOPS	8	1.0
B	DCSLOG	24	1.0
C	DCSPER	5	1.0
D	DCSRDA	4	1.0
E	ACSAC	0	–
F	TAG	4	0.9
G	TSG	1	0.9
H	CE	15	0.9
		61	

Figure 24. Group merge factors used in the revised model.

5 CONCLUSION

This report describes three versions of a model concept for quantifying the force readiness contribution of a funding entity relative to the contribution of other funding entities. These versions are all viable solutions to the readiness quantification problem. All versions have six favorable characteristics: they are logically simple; complete; consistent; foster efficient conflict resolution among staff evaluators; enable ratings to be easily adjusted as weighting decisions change at any managerial level; and provide an integrated and dynamic management approach to the quantification of readiness worth. All but the manual version need mainframe support before they can be used efficiently. The manual version of the model uses simple algorithms to quantify the readiness merits of a few marginal MCA facility projects without too much computational effort.

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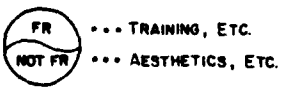
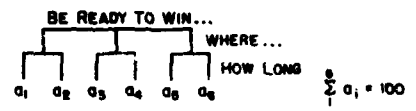
Location	Project Number	Project Description	CAT	PRO	MACOM	PA($K)	Facilities Readiness B_R/C_T	New Facilities Readiness Rank	Old Facilities Readiness Rank
Germany	414	Igloo Stg-Various	422	LOG	USAREUR	1,700	29.1	1	1
Germany	277	Basic Load Site-Hanau	422	LOG	USAREUR	2,700	28.1	2	3
Germany	600	Tac. Eq. Shop-Bremerhaven	412	LOG	USAREUR	2,050	27.4	3	2
Germany	423	Maint. Facs. Mod-Hohenfels	214	LOG	USAREUR	4,000	24.5	4	5
Germany	924	Vehicle Maint Shop-Bamberg	214	LOG	USAREUR	7,900	24.3	5	4
Germany	594	Subcal Tank RG-Bad Hers	179	OPS	USAREUR	1,200	21.4	6	7
Germany	391	Simul City Mout-Hohenfels	179	OPS	USAREUR	4,450	20.8	7	6
Loc 276	140	Water Purification Plant	831	OCE	INSCOM	5,400	19.9	8	8
Germany	339	Surveil & Maint Fac-Miesau	216	LOG	USAREUR	7,000	18.7	9	13
Loc 177	029	Aircraft Maint Hangar	211	LOG	INSCOM	1,100	18.6	10	9
Ft. Riley	117	Acft Mnt Hangar Shop Addn	211	LOG	FORSCOM	1,350	18.4	11	14
Loc 276	136	HVAC Upgrade	890	OCE	INSCOM	700	17.5	12	11
Korea	654	Airfld Fac Upgrade-CP Hump	111	OPS	EUSA	6,100	17.3	13	10
Turkey	207	Utilities Upgrd-Det 67/168	812	OCE	USAREUR	510	15.9	14	12
Turkey	206	Dispensary-DET 67/168	550	TSG	USAREUR	510	15.4	15	16
Ft. Hood	358	Tact Equip Shop	214	LOG	FORSCOM	7,300	15.4	16	17
Korea	690	Tact Equip Shop-Taegu	214	LOG	EUSA	1,000	15.2	17	15
Germany	940	Forklift Chrg Sta-Various	218	LOG	USAREUR	530	14.2	18	18
Schofld Bks	103	Aircraft Hangar-Wheeler	211	LOG	WESTCOM	9,900	13.5	19	23
Aber Pr Gr	286	Kinetic Energy Launch Sys	310	RDA	DARCOM	2,800	13.4	20	21
Wtrvlt Ars	047	Facilities Mod Ph 3	225	RDA	DARCOM	10,400	13.2	21	24
Germany	931	Surv Test Range-Weilerbach	179	OPS	USAREUR	350	13.0	22	22
Korea	689	POL Pipeline Stg-Kunsan	411	LOG	EUSA	4,750	12.9	23	25
Germany	798	Barracks W/Facs-Bamberg	721	PER	USAREUR	20,000	12.6	24	28
Ft. Benning	342	Tactical Equip Shops	214	LOG	TRADOC	4,150	12.5	25	29
Germany	925	Dining Facility-Bamberg	722	LOG	USAREUR	2,850	12.3	26	26
Germany	939	Ammo Surv Bldg-Vilseck	216	LOG	USAREUR	410	12.2	27	30
Germany	923	Bn Hq & Classrms-Bamberg	171	PER	USAREUR	1,250	12.1	28	27
Japan	176	Ammo Stg Fac-Kawakami	421	LOG	USARJ	1,950	11.6	29	34
Okinawa	712	POL Line Modifications-Var	125	LOG	USARJ	610	11.5	30	19
Turkey	201	Barracks w/Dng-Det 67/168	721	PER	USAREUR	4,000	11.3	31	31
Turkey	301	Barracks-Det 74	721	PER	USAREUR	1,900	11.3	32	32
Turkey	401	Barracks-Det 155	721	PER	USAREUR	1,900	11.3	33	33
Korea	650	Mono Buoy System-Pohang	163	LOG	EUSA	350	11.1	34	20
Korea	701	Barracks-Yongsan	721	PER	EUSA	3,400	10.7	35	36
Mot Bayonne	052	Exterior Lighting	812	OCE	MTMC	240	10.1	36	35
Kwajalein	222	Rkt Assem Bldg-Roi Namur	212	LOG	BMDSC	1,200	9.4	37	37
Turkey	204	Sup Office/Whse-Det 67/168	441	LOG	USAREUR	1,000	8.3	38	38
Kwajalein	217	Marine Shop	213	LOG	BMDSC	1,600	7.7	39	39
Kwajalein	218	Live Explosive Storage Fac	422	LOG	BMDSC	550	6.6	40	40
Pres San Fr	110	Emerg Generator	811	TSG	FORSCOM	790	5.9	41	41
Turkey	402	Admin Bldg-Det 155	610	PER	USAREUR	900	5.1	42	43
Turkey	302	Admin Bldg-Det 74	610	PER	USAREUR	750	5.1	43	44
Ft. Carson	281	Land Acquistion	911	OCE	FORSCOM	26,000	5.0	44	42
Turkey	203	Admin Bldg-Det 67/168	610	PER	USAREUR	1,300	4.7	45	45
Turkey	205	Cmunity Act Fac-Det 67/168	740	TAG	USAREUR	1,100	4.6	46	46
Turkey	403	Community Act Fac-Det 155	740	TAG	USAREUR	600	4.6	47	47
Turkey	303	Community Act Fac-Det 74	740	TAG	USAREUR	520	4.6	48	48
Ft. Eustis	303	Gen Instruct Bldg Addn	171	OPS	TRADOC	3,850	4.5	49	49
Coldreg Lab	008	Frost Effects Res Fac	310	RDA	ENGRS	6,900	4.2	50	51
Redriver Ad	070	Add & Alt Depot Opns Bldg	442	LOG	DARCOM	1,900	4.1	51	50
Ft. Detrick	172	Barracks Modernization	721	PER	HSC	1,450	3.7	52	52
Ft. Monmouth	140	Modernize R&D Bldg	310	RDA	DARCOM	20,000	2.3	53	53
Ft. Hood	380	Div Hq & Opns Bldg	141	PER	FORSCOM	9,700	1.7	54	54
Ft. Myer	112	Alter Barracks	723	PER	MDW	840	1.5	55	55
USMA	123	Improve Utility Systems	890	OCE	USMA	3,150	1.3	56	56
Rk Isl Ars	081	Alt Bldg for Hq Fac-Ph II	610	LOG	DARCOM	7,400	1.0	57	57
Coldreg Lab	006	Vehicle Storage Bldg	441	LOG	ENGRS	180	0.8	58	58
Ft. Campbell	252	CIDC Field Operations Bldg	141	PER	CIDC	1,150	0.4	59	59
Germany	784	Banking Fac-Frankfurt	740	TAG	USAREUR	480	0.2	60	60
Ft. Leaven	075	Renovate Admin Bldg	610	PER	TRADOC	7,200	0.1	61	61

Figure 25. Comparison of facility project ranks from Versions 1 and 2 of the model.

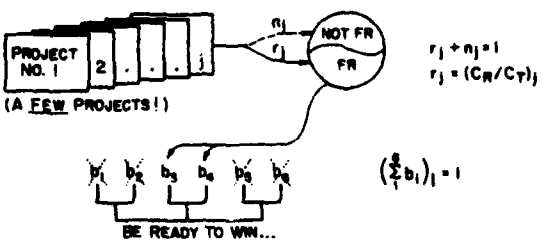
1. USE THE JULY 80 FIELD TEST DEFINITION OF FORCE READINESS (FR):



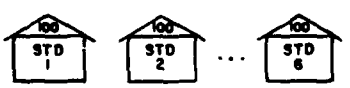
2. WEIGHT EXISTING 6-NODE MISSION HIERARCHY:



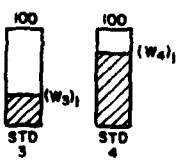
3. DECIDE EACH PROJECT'S RELEVANCE TO FR AND TO FR SUBOBJECTIVES:



4. DEFINE ONE MAX CONTRIBUTION PROJECT FOR EACH OF THE 6 MISSION AREAS:



5. COMPARE PROJECT WORTHS TO APPROPRIATE STANDARDS:



6. COMPUTE THE FINAL B_R/C_T:

$$\left(\sum_{i=1}^{6} a_i b_i w_i\right)_j \times r_j = (B_R/C_T)_j = (B_R/\$PA)_j$$

7. REVIEW AND DISCUSS RESULTS:

RANK	B/C
1	15
2	12
3	8
.	.
.	.
.	.
j	2

Figure 26. Procedures for the manual implementation of the model (Version 3).

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Pacific Ocean 96858
South Atlantic 30303
South Pacific 94111
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